LESSONS

ON

THE UNIVERSE:

THE

ANIMAL, VEGETABLE, AND MINERAL KINGDOMS; AND THE HUMAN FORM.

BEING THE THIRD VOLUME

OF THE

INSTRUCTOR.

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LESSONS ON THE UNIVERSE.

THE THREE KINGDOMS OF NATURE.

THE UNIVERSE.

LESSON I. *The Universe.*

WE understand by the word Universe the entire system of things which God has created. The world in which we live forms a very small part of the universe. There are numberless other worlds, far surpassing ours in magnitude. Many of these worlds, that cannot be seen in the day-time, may be seen with the naked eye in a clear night. They appear, indeed, like points of light; but,

if they were not very large, we should not be able to discern them at all: they are always moving about in that vast blue vault above our heads. We call that vault the Heavens; and we know it to be a space which is without any limit or end.

We name the world in which we live, the Earth; we name the bodies which give or reflect light, the Sun, the Moon, and the Stars. These bodies are shaped like balls, and from their shapes, are called globes, or orbs.

Some of the heavenly orbs are supposed to be inhabited, but they are unfit for the abode of such a being as man, who lives on the earth. Their inhabitants must, therefore, be of a different nature from ourselves. The Almighty Maker, we may be assured, has adapted these worlds to the nature of the beings whom He has placed in them.

Men who observe the stars and the other heavenly bodies are called Astronomers. The science which they cultivate is called Astronomy.

Astronomers call the space in the heavens, through which an orb moves, its Orbit. They call any straight line passing through the centre of an orb, and ended at each extremity by the circumference, a Diameter; and the diameter round which an orb is supposed to move, they call its Axis.

QUESTIONS.

What is the universe?
Does the world in which we live belong to the universe?
Are there other worlds besides ours?
When are they to be seen?
What is their appearance?
Do the heavenly bodies stand still or move?
What is the world in which we live called?
Which are the bodies that give, or reflect light?
Of what shape are they?
What are they called in consequence?
Are any of the heavenly bodies supposed to be inhabited?
What is the space called through which they move?
What is the diameter of an orb?
What is the axis of an orb?

LESSON II. *The Sun. The Moon. The Solar System.*

THE SUN is the largest of all those orbs which we behold in the heavens. It is supposed to be surrounded by a luminous atmosphere, from which light and heat are transmitted to the earth which we inhabit, as well as to the other orbs, which all move round the sun as their centre. The diameter of the Sun is 883,246 miles; a space so vast that it is difficult to convey a correct idea of it.

Next to the Sun, the Moon is, to us, the most interesting object among the heavenly bodies. The dazzling splendour of the Sun renders a full view of it painful to the human sight. The brightness of the Moon, on the contrary, arising from the Sun's reflected light, is grateful and pleasing to the eye, and its silvery beam relieves the dulness of our long winter nights. Its

changes from the thin crescent to the full or; and its waning from the full to the crescent again lead us to admire the wisdom and power of God, by whom all these wonderful things were made and who regulates all their motions.

The Earth, and the other orbs which move round the Sun, thirty-four in number, compose what is styled the Solar System. They are called Planets, (from a Greek word signifying *a wanderer*, in allusion to their ceaseless motion,) and are divided into Primary and Secondary. Primary Planets move round the Sun in circles of many millions of miles in diameter; Secondary Planets move round some one of the primary planets, and are called their Moons or Satellites. All the planets move also round their own axes; some in a longer, others in a shorter time; and the length of their day varies accordingly, being in one less than ten hours, and in another nearly thirty days, according to our reckoning.

QUESTIONS.

What is the sun?
How great is its diameter?
What does it give to the earth?
In what respect does the light of the moon differ from that of the sun?
What season is relieved by the influence of the moon?
What alterations in form does the moon undergo?
What does all this lead us to admire?
What do you understand by the solar system?
How many of the heavenly bodies move round the sun?
What are they called?
What does planet mean?
What are primary planets?
What are secondary planets?
What other names are given to them?
What determines the length of day of the planets?

LESSON III. *The Planets. Comets. The Fixed Stars. The Solar System.*

THERE are fifteen primary planets, named Mercury, Venus, the Earth, Mars, Vesta, Juno, Ceres, Pallas, Astræa, one discovered in 1847, Jupiter, Saturn, Uranus, called also Herschel, or the Georgium Sidus, Neptune, Iris, and nineteen satellites, or moons.

Mercury, the nearest to the sun, but distant from it thirty-seven millions of miles, is 3224 miles in diameter, and performs its journey round the sun in about eighty-eight days.

Venus is 7687 miles in diameter, and revolves round the sun in 224 days 16 hours, at the distance of about sixty-eight millions of miles. This is the brightest of all the planets, and is sometimes to be seen in the day-time with the naked eye. It is called the Morning Star, when it is to the westward of the sun, and therefore rises before him; and the Evening Star, when it is to the eastward, and sets after him.

The Earth, on which we live, is nearly eight thousand miles in diameter. It revolves upon its axis in twenty-four hours, which is our day, and completes its journey round the sun in 365 days, 6 hours, and some minutes, which constitute our year; and it travels in that time 550

millions of miles. The Moon is the constant attendant of the Earth, round which it revolves at the distance of 240,000 miles, and is about 2000 miles in diameter. The moon is the nearest to us of all the heavenly bodies, and in size about one sixty-fourth part of the Earth.

Mars is 4189 miles in diameter, and about one-fifth as large as the Earth. It is 145 millions of miles from the sun, and revolves round it in 687 days.

Vesta, Juno, Ceres, Pallas, Astræa, and another, are six small planets, discovered in the present century, which revolve between Mars and Jupiter. Juno, the largest, is supposed to have a diameter of 1400 miles, while that of Pallas does not exceed eighty. Their distances from the sun vary between 225 and 275 millions of miles.

Jupiter is 500 millions of miles distant from the sun, around which it revolves in about twelve years. It has a diameter of almost 90,000 miles, and is 1470 times as large as the Earth. This planet, the largest of the Solar System, is remarkable for four moons, which move round it, as our moon moves round the Earth; and during its nights, they reflect upon it light received from the sun.

Saturn is 900 millions of miles from the sun;

it is nearly 80,000 miles in diameter, and requires twenty-nine years and a half to perform its journey. Saturn has seven moons revolving round it, and reflecting upon it the sun's light. It is encircled also by a broad ring, that is always brilliant, composed of two distinct parts, separated by a space of nearly 3000 miles. It is in breadth about one-third of Saturn's diameter, and at the same distance from the planet.

The planet Uranus takes eighty-three years to complete its revolution round the sun. Its distance from that luminary is 1822 millions of miles. Being about 35,000 miles in diameter, it is seventy-eight times as large as our Earth.

Neptune is 2800 millions of miles from the sun, and takes 167 years to revolve round it.

Comets.

A Class of moving bodies, occasionally seen followed by a train of light, which bears a fancied resemblance to flowing hair, are thence called Comets, from the Latin word *coma*, hair. At their first appearance comets are scarcely perceptible, but as they approach the sun they increase in brightness and velocity; and then, by degrees, diminish and disappear. Their motions are very irregular. It is supposed that there are at least a thousand comets belonging to our system.

The Fixed Stars.

THE other heavenly bodies which are seen in the Firmament are called Fixed Stars: they are known by their twinkling, which distinguishes them from the planets. The number of stars which may be seen at any time by the naked eye is not much above one thousand; but 44,000 have been discovered by the aid of the telescope; and many of them have been arranged in groups called Constellations; twelve of these which lie on the line which the sun appears to describe round the Earth, are styled the Signs of the Zodiac, and other stars are found by reference to their position.

QUESTIONS.

How many primary planets are there?
What are their names?
Which of them is nearest to the sun?
Which is the next?
For what is Venus remarkable?
What is the diameter of the earth?
In what time does it make its journey round the sun?
What do we call that period?
What is the size of the Moon?
What is the size of Mars?
Which are the lately discovered planets?
What is the diameter of Juno?
Which is the largest of the planets of the solar system?
How far is Saturn distant from the Sun?
How long is Saturn in performing its revolution?
What is the distance of Herschel from the sun?
What are comets?
Are their motions regular?
What are the fixed stars?
How may the fixed stars be readily distinguished from the planets?
What number may be seen by the naked eye?
How many have been discovered with the telescope?
What are the Signs of the Zodiac?

General View of the Solar System.

To give some general idea of the relative size and position of the various members of the Solar System, an eminent philosopher of the present day informs us that if we imagine our Earth to be represented by a twelve-inch globe, then the Sun will appear as a globe a hundred feet in diameter (about the size of the dome of St. Paul's), two miles off; and the Moon, three inches in diameter (the size of a cricket-ball), thirty feet off. Mercury, rather larger than the Moon, will appear about a mile and a quarter from the Earth; and Venus, nearly as large as the Earth, about a mile and a half from the Sun. Mars, seven inches in diameter, is three miles from the Sun; Jupiter, eleven feet, is ten miles off; Saturn, ten feet, is nineteen miles distant; and Uranus, three feet and a quarter, forty miles. The places of the six small planets lie between five and seven miles from the Sun, but the magnitude of the largest would be less than that of a grain of sand.

QUESTIONS.

How has an eminent philosopher proposed to represent the parts of our system?
What represents the Sun?
What represents Mercury?
What represents Venus?
What represents the Earth?
What represents Mars?
What represents Jupiter?
What represents Saturn?
What represents Uranus?
What are the sizes and distances of Juno, Ceres, Vesta, and Pallas?

Lesson IV. *Form and Magnitude of the Earth.*

It is difficult to discover the form of the Earth by merely looking upon it, because we can see but a small part of it at once, and because we are too near to it. The general form of an object is, however, to be ascertained by the form of its shadow. Now, whenever the Earth, in its journey round the Sun, happens to be in a straight line between the Sun and the Moon, it always casts a circular shadow upon the face of the Moon, and thus we know that the Earth is round, like a globe.

The distance round a globe is called its

circumference. The circumference of the Earth is about 25,000 miles. It is possible, then, to travel round the Earth; if you turn your back on your home, and continue to travel with your face to the west, the quarter in which the sun sets, you will arrive at home again from the east, or the quarter in which the sun rises. A voyage round the world may be performed in a year, if a ship does not stay long in a place, and wind and weather prove favourable.

Land and Water.

THE Earth consists of two parts, Land and Water. It has an uneven surface, occasioned by the many mountains which are upon it. But the mountains, though many of them seem to us very lofty, are, when compared to the size of the Earth, as small as grains of sand on a cricket-ball; or the roughness on the rind of an orange. The water occupies about twice as much space on the surface of the Earth as the land.

Representations of the surface of the Earth are called Maps. On a map which represents the whole world you see two large circles. But you must not on that account imagine that the Earth consists of two such circles. The whole surface of a globe or ball cannot be shown in any other way. Suppose you wanted to represent

the whole surface of an orange, you would be obliged to draw it as two circles. Each of the circles which represent the Earth is called a Hemisphere. The word Hemisphere means half globe.

The land of the Earth is divided into five great parts, each of which has a distinct name. The smallest part, situate towards the top of the eastern hemisphere, is called EUROPE, and to this belongs the country in which we live. Hence we call ourselves Europeans as well as Englishmen. In the same hemisphere are situate three other parts of the world, ASIA, AFRICA, and part of AUSTRALASIA. In the western hemisphere lie AMERICA and part of AUSTRALASIA.

You find upon a map outlines of countries, with their names, and the names of their principal cities. The names of countries are distinguished by capital letters. Black crooked lines show the courses of rivers, and dark patches in the midst of the land are large lakes. Land surrounded by water is called an Island; land nearly surrounded by water is called a Peninsula; and the neck of land which connects such countries with others is called an Isthmus.

Hills, Mountains, Mines, Caverns.

IN most parts of the earth there are Hills and

Mountains. Some of these are composed wholly of stone, which is useful to man for many purposes. In different places, both the hills, which rise above the ground, and the earth, which is beneath it, contain copper, iron, and other valuable substances, mixed with earthy matter. In many places, coal, salt, and various other productions of great value, are found deep in the bowels of the earth. The large and deep openings made to obtain them are called Mines, and the earthy or stony matter, among which the metals and minerals are found, are called Ores. Men employed in digging mines are called Miners.

Mountains which send forth flames and clouds of smoke are called Volcanoes. These sometimes discharge also streams of liquid matter called lava, which look like rivers of fire, and spread terror, death, and destruction around. The principal volcanoes in Europe are Vesuvius, near Naples, and Ætna, in Sicily.

Fire and water have formed in the earth many extraordinary Caverns, some of which run for miles under ground, and terminate in abrupt precipices. The water incessantly dropping from the roofs of caverns, sometimes forms what are called Stalactites, which hang down in a variety of curious and beautiful shapes.

In some parts of the earth mighty torrents

have broken through and rent asunder huge mountains, the sides of which now form, as it were, immense gateways. Such was the origin of the Straits by which some countries are separated, and seas have become connected: the Straits of Gibraltar supply an instance, where Europe and Africa approach near to each other, and by which the Mediterranean Sea is connected with the Atlantic Ocean.

QUESTIONS.

How may the shape of a body be discovered?
How do we know that the earth is round?
What is the circumference of a globe?
What is the extent of the earth's circumference?
If we were to set out and keep travelling in one direction, what would happen?
How long would a voyage round the world occupy?
Of what does the earth consist?
What proportion does the water bear to the land?
Is the surface of the earth even or uneven?
What occasions the inequality?
How is the earth represented in maps?
What name is given to each of the circles?
What is the meaning of hemisphere?
Into how many principal parts is the world divided?
What are their names?
Which is the smallest of them?
In which of the hemispheres is Europe?
What other parts of the world are in the same hemisphere?
Which of them are in the other hemisphere?
How are rivers marked in maps?
What is an island?—A peninsula?—An Isthmus?
Of what are mountains composed?
Where are metals and minerals found?
What is a mine?
What are volcanoes?
What are the principal European volcanoes?
By what means have caverns been formed?
What has been the effect of torrents?

THE Water which encompasses the land is called the Sea. This purifies the Earth from unwholesome vapours by drawing them into itself, and it is for the most part of vast depth. Its depth, however, is very unequal; for, like the surface of the land, the bottom of the sea consists of mountains and valleys. From the bottom of the sea are often raised wonderful masses of rock, called Coral Reefs, in which little animals make their habitations.

As the boundless extent of the sea, and its majestic movement, fill the mind with delight, astonishment, and awe, so in the dark its luminous appearance is very splendid. Very often the sea, as far as the eye can reach, seems to be on fire. This wonderful appearance is produced by very small animals, scarcely so big as a pin's head, with an extremely delicate, transparent, jelly-like body, mixed with others called Medusas and Sea-nettles, which emit light from their long feelers or horns, while their bodies remain quite dark.

The saltness of the sea-water renders it less liable to freeze than other water. But the sea at both Poles, or the north and south points of the earth, forms islands and mountains of solid ice,

called Icebergs, which never melt, even in the midst of summer.

All the countries of the world are supplied with fresh water by streams which run through them. Large streams are called Rivers, and run into the sea: smaller streams are called Rivulets. Many rivers are very broad and deep. When a river is so deep that large ships can sail upon it, we call it a Navigable River. The hollow in which the water of a river flows is called its channel or bed. The margin of the bed is called the bank. In many rivers there are places where the water tumbles over steep precipices to a great depth. Such places are called Waterfalls, or Cataracts. Pieces of water, surrounded by land, are termed Lakes. There are lakes more than one hundred miles in length and breadth.

QUESTIONS.

What does the bottom of the sea consist of?
What is the appearance of the sea at night?
By what is this produced?
Why is salt water less liable to freeze than other water?
What appearance has the sea at the two poles of the earth?
What are icebergs?
How are the countries of the world supplied with fresh water?
What names are given to the streams of fresh water?
What is a navigable river?
What are waterfalls, or cataracts?
What name is given to large pieces of water surrounded by land?

Lesson VI. *The Atmosphere. The Winds; Dew; Fogs; Clouds.*

The Earth is surrounded on all sides by Air. The air, with the vapours that it contains, is called the Atmosphere. The higher we ascend into this atmosphere, for instance, upon high mountains, the thinner does the air become, and the less does it press upon the body.

The pressure of the atmosphere upon the human body is equal to fifteen pounds upon every square inch; and, as a man's body contains, upon an average, fifteen square feet of surface, he must sustain a weight of 32,400 pounds, or sixteen tons, for his usual load. By this enormous pressure we should be crushed to atoms in a moment, if every part of our body were not filled either with air, or with some elastic fluid, the spring of which is just sufficient to counteract

the weight of the atmosphere. On the tops of high mountains, the pressure of the atmosphere is so much less than what it usually is on the plains, that travellers suffer exceedingly who ascend them, not only from the intense cold, but also from difficulty of breathing. The height to which the atmosphere extends is generally supposed to be about sixty miles, above which elevation there are neither clouds nor wind, and the lightness or rarity of the air would render it impossible for any creature constituted like the inhabitants of the earth to exist.

The vapours, which are continually rising from the earth, and from everything upon the earth, collect in the atmosphere, and, uniting together, produce rain, snow, fog, and all other changes of weather.

Winds.

The winds which are continually blowing over the earth are nothing but air put in motion, chiefly by means of heat. When any part of the air is heated by the rays of the sun, or any other cause, it is expanded, and becomes lighter; and as the lightness causes it to ascend, it leaves a partial void, or space, into which the surrounding air rushes, to fill up the void, and restore the balance. For air, like water, and every other fluid, never rests until it has found its level.

This simple process, the effects of which are very extensive, meeting with various checks and interruptions from numberless obstacles, causes those agitations of the air, which are called wind. When the wind is violent, it is called a storm, or tempest; and when it is very furious, a hurricane. Storms and hurricanes sometimes break and uproot the strongest trees, overthrow houses, and lay waste large tracts of country; but these destructive effects are seldom witnessed in our happy land.

What is commonly called a high wind, which does not amount to a storm, generally moves at the rate of about thirty-five miles an hour; and in a hurricane the velocity of the wind is calculated at one hundred miles in an hour, and far exceeds the velocity of a cannon-ball.

Dew.

DEW arises from the watery vapours which ascend in the day-time from the earth, and, being condensed by the cold at night, fall down again. When, therefore, the night is very warm, there falls little or no dew. When it is so cold that the dew is frozen, it is then called hoar-frost; and the trees and grass appear as white as if they were powdered. The reason is this: when trees and other bodies are extremely cold, the vapours

falling upon them are changed into particles of ice. In very severe cold, even the vapours issuing from our mouths are frozen, and fasten themselves in that state to the hair, as the dew does to the grass.

Fogs.

Fogs, or mists, consist of watery particles, which are raised into the air, where, not being completely dissolved, they form a vapour, which extends itself in the lower part of the atmosphere, and is so thick that objects cannot be seen through it.

Fogs are more frequent in low, wet, and marshy situations, near rivers and ponds, than in those parts of a country which are high and dry. Fogs are much more common in cold seasons and in cold climates than in such as are warm; because, in the former, the watery particles, being condensed almost as soon as they proceed from the surface of the earth, are prevented from rising high in the atmosphere.

The light mists which are observed in serene summer evenings are composed of the same kind of watery particles, rendered visible by the cooling of the air. In winter, when it freezes sharply, rivers that are not yet frozen appear to smoke, because the upper layers of water, on account of their greater heaviness, sink to the bottom, and

cause the warmer water below to rise to the top; and the particles rising from the warmer water assume the appearance of smoke.

Clouds.

When vapours rise to a height in the atmosphere, and are collected in a dense state, they form clouds, which float in the atmosphere at a greater or less height, according to their weight. As the atmosphere is heaviest below, dense and thick clouds, which are on the point of melting into rain, float near the surface of the earth, while the thin fleecy clouds soar far above them. Both kinds may be frequently seen at different heights in the atmosphere at the same time.

Clouds being formed of water, are produced in greatest abundance where the air has most opportunity of acting upon water. Winds, therefore, which blow from the west and south-west, over the wide Atlantic Ocean, bring more clouds to this country than easterly winds, which pass over only a narrow channel of the sea.

The wonderful variety of colours displayed by the clouds, arises from the different ways in which the sun's light is reflected among them. Many of the clouds rise to the height of fifteen miles from the surface of the earth; but their general height is not above a mile.

QUESTIONS.

By what is the globe of the earth surrounded?
What general name is given to the air and the vapours which it contains?
What is calculated to be the pressure of the atmosphere upon a man's body?
How is this enormous pressure counteracted?
What happens on mountains?
To what height is the atmosphere supposed to extend?
What is produced by the vapours that rise from the earth into the atmosphere?
What is wind?
What effect is produced upon the air by heat?
What is the consequence of the air being rendered lighter?
What do we call the agitations caused in the air?
When the wind is violent what is it called?
What name do we give to the most furious winds?
What are their effects?
At what rate does a high wind move?
What is the velocity of the wind in a hurricane?
From what does dew arise?
How is dew formed?
When the dew is frozen what is it called?
Of what do fogs consist?
Where are fogs most frequent?
When are they most common?
How are clouds formed?
Where are they produced in greatest abundance?
What winds bring most clouds to this country?
What causes the variety of colours in clouds?
What is the general height of clouds above the earth?
To what height do they often rise?

LESSON VII. *The Atmosphere. Evaporation; Rain; Snow; Hail; Rainbow.*

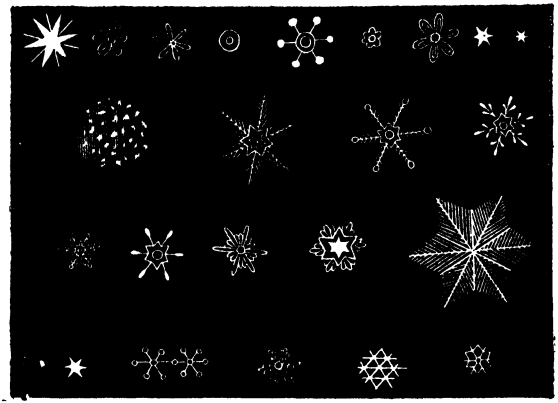
ACCORDING to the wise decrees of the Creator there is a process in nature constantly going on, by which a portion of all liquids is converted into steam or vapour. This process is called Evaporation. It prevails to a certain extent in all countries and all situations, but the result is much more apparent in warm than in cold climates.

Now God has provided that the whole of the water that is raised by evaporation shall not subsist in the atmosphere at one time in the state of vapour. A portion of it is continually returning to the earth, and not a single day passes without Rain, as it is called, falling in some part of the world. The secondary cause of rain is the condensation of the clouds through the effect of cold. When they are greatly condensed, they become too heavy to float in the air, and descend in drops.

The cold of the higher regions of the atmosphere is sometimes so great as to freeze the watery particles which form clouds. If the particles become frozen before they have had time to unite into drops, they descend in the shape of small stars with six points; and several of these joined together, form flaky masses, which are called Snow.

The quantity of matter contained in snow is small in proportion to its bulk. Snow, therefore, meets with great resistance in passing through the atmosphere, and consequently falls much more slowly than rain. Its great surface, also, renders it very susceptible of evaporation, which considerably diminishes its weight before it reaches the surface of the earth, even in the coldest weather.

The following is a figure, showing some of the forms in which the flakes of snow descend.



If the cold is so moderate as to allow the particles of water to unite into drops before freezing takes place, they form pieces of ice, called Hail. Hail, when first formed, is not larger than the drops of water which fall in rain; and being formed from a fluid, it must be perfectly round: but when it arrives at the earth it is often sharp-cornered, and as large as nuts, or even as hen's eggs. In these cases, either the particles composing such hail-stones have begun to dissolve, or they were sufficiently cold to congeal and attach to their surface the particles

with which they came in contact during their fall.

If, when the sun is shining, a shower of rain falls either around or at some distance before us, we may see in the air opposite to the sun a large bow, of bright and beautiful colours, which is called a Rainbow. This striking appearance is caused by the sun's rays being refracted, or broken, in the falling drops. The uppermost colour of the rainbow is red, and the lowest violet. The moon also sometimes shows a rainbow, formed by the refraction of her rays in drops of rain during the night: but this appearance, called the Lunar rainbow, is very rare.

QUESTIONS.

Where is evaporation most copious?
How is rain produced?
What is snow?
Why does snow fall so slowly?
What is hail?
What produces the appearance called the rainbow?
What name is given to the rainbow formed by the moon's rays?

LESSON VIII. *Electricity; Thunder and Lightning.*

GOD has also provided a matter, respecting which we know little more than that it communicates to certain bodies the power of attracting, and after a while repelling, other bodies. At the same time, a spark of light appears, a snapping noise is heard, and a shock, as it is termed, is communicated. This matter is called electricity.

When, for example, a glass tube is rubbed with a woollen cloth, small pieces of paper, straw, feathers, or other light bodies held over it, will be first drawn towards the tube, and then driven from it. If you put your finger to this tube in the dark, you see a spark, hear a snap, and feel a slight pricking in the finger. If you rub the tube hard for some time, and then hold it near your face, you fell a sensation, as if a cobweb were spread upon your cheek. Similar effects are produced by other substances when they are rubbed, such as amber, sulphur, porcelain, and sealing-wax.

The observation of these facts led to the construction of a machine, by which electricity can easily be produced, and which is called the Electrical Machine. By means of this machine,

sparks have been produced of such power as in an instant to melt metals and to kill animals. This electric matter subsists in the clouds called thunder-clouds, from which it issues in the form of flashes of fire, which are called Lightning. The noise which usually follows the flash, or the lightning, we call Thunder.

The electric flame, which we call lightning, when it strikes a tree or a house, either damages or destroys it entirely, or sets it on fire. If it strikes men or beasts, it either stuns, maims, or kills them. God, however, in his mercy, generally protects his creatures from harm; and in the benefits that He has caused to attend thunder-storms, compensates any mischief they do. Thunder-storms cool the atmosphere and purify it from noxious vapours, and the rain which usually accompanies thunder and lightning promotes the fertility of the soil and the growth of plants.

Men have invented a contrivance for securing buildings from the effects of lightning. A long iron rod, called a lightning conductor, is erected close to the house, in such a manner that the lower end descends into a cistern of water, and the upper rises above the roof. A rod of this kind attracts the lightning, and conducts it down to the earth without injury to the building. A

house surrounded by tall trees is rarely struck by lightning, because the lightning is attracted by the trees. Therefore, remember not to take shelter under trees during a thunder-storm. The safest situation, without doors, during a storm, is within some yards of trees; and in-doors, the middle of an apartment.

Sound is transmitted at the rate of 1142 feet, or 380 yards, in a second; the distance of lightning, and the probable danger, may therefore be calculated, by observing the time which intervenes between the flash and the report, which if equal to three beats of the pulse shows the thunder-cloud to be almost a mile off.

Ignis-Fatuus; Falling Stars; Aurora Borealis.

We have all heard of the lights called Will-with-a-Wisp, or Jack-with-a-Lantern, which learned men style Ignis-Fatuus. These lights are seen most frequently in mines, in marshy places, and near stagnant waters. They consist of vapours, which, taking fire, appear bright so long as they burn. They move about with a dancing motion, and have sometimes caused serious accidents, by misleading persons who have followed them in the dark, under the idea that they were lanterns carried by passengers.

Balls of Fire sometimes descend from the upper region of the atmosphere. When they fall, they look precisely like stars dropping from the sky, and have thence obtained the name of Falling Stars. They shoot along with great rapidity, and sometimes leave behind them, in the air, a reddish line, which gradually disappears. Sometimes their motion is attended by a hissing sound, and they burst with a loud noise. Their light is of dazzling brightness. They have been often observed, but their nature and cause are not satisfactorily known.

Sometimes at night there is to be seen, in the northern quarter of the heavens, a bright light, like the morning Aurora, or day-break, from which rays issue, and which spreads itself by degrees over a great part of the firmament. The whole heavens at length appear red and fiery, and exhibit a most beautiful sight. This appearance is called the Northern Light, or Aurora Borealis; it is supposed to be, like lightning, an effect of electricity, and in the dreary countries of the North it greatly assists in dispelling the gloom of the Winter. The Aurora Borealis is peculiar to clear, cold, and dry weather, and does not occur in tropical climates. In former times the appearance of the Aurora was imagined to indicate the approach of war

or other evils, but such idle fancies have now *happily vanished.*

QUESTIONS.

In what form does the matter called electricity show itself?
How may it be produced?
What other substances exhibit similar effects?
What is the nature of lightning?
What do we call the noise that follows the flash?
What is the effect of lightning when it strikes an object?
In what respect are thunder-storms beneficial?
How may buildings be secured from injury by lightning?
Why is a house surrounded by high trees rarely struck by lightning?
Is it then prudent or imprudent to take shelter under trees in a thunder-storm?
How may the distance of lightning be calculated?
On what principle is that calculation made?
What is the ignis-fatuus or Will-with-a wisp?
Where is it most frequently seen?
What does it consist of?
What kind of motion has it?
What are the bodies commonly called falling stars?
What appearance have they?
What kind of appearance is the aurora borealis, or northern light?

LESSON IX. *Different Races of Mankind.*

THE whole world is supposed to contain above 800 millions of human inhabitants. Of these, such as dwell together in one country, and are of the same general stature, colour, language, and manners, form a people, or Nation.

Each of the principal divisions of the world is subdivided into smaller portions, called Countries: there are various nations in each of the great divisions of Europe, Asia, Africa, America, and Australasia; but all the different people in

the world bear some resemblance to each other, either in shape, colour, look, or mode of life.

We are informed in the Sacred Scriptures, that all the races of mankind, scattered over the surface of the globe, notwithstanding the differences that the observer may at once discover between them, are descended from one pair. We also read in the same inspired record, that after the destruction of the former race by the Flood, the whole earth was repeopled by the descendants of the three sons of Noah. The influence of climate, food, and civilization, particular modes of life, and a variety of causes, have, however, produced many and striking diversities in the outward appearance of the human form.

Those persons whom we term Naturalists, because they devote particular attention to the study of Nature in all its branches, divide mankind into several principal races;—as the Polar or Lapland race; the Mongol, or Tartar; the Negro, or Ethiopian; the Red, or Copper-coloured; and the White Race.

QUESTIONS.

How many inhabitants are there supposed to be in the world?

What constitutes a nation?

What ground have we for believing that the different nations of the world have all sprung from one pair?

What causes have produced the striking differences observable in the various races of mankind?

Into what principal races are mankind generally divided?

LAPLANDER.

SAMOYEDES.

LESSON X. *The Polar Race.*

ALL the Northern parts of the two hemispheres into which the globe is divided, are peopled by nations belonging to the Polar race, who are very dark, having a flat visage, and black hair and eyes. They are thick in form, and extremely short in stature. To this race belong the Laplanders, in Europe; the Samoyedes, the Ostiaks, the Tchuktchi, and the Kamtschatdales, in Asia; the Greenlanders and the Esquimaux, in America. The inhabitants of Finland in Northern Europe resemble these nations in almost every circumstance, excepting their height, which nearly equals that of other Europeans. Living under a severe climate, and subsisting on particular kinds of food, their nature seems to have been affected by the hardness of their fare, as well as their complexion by the intense cold.

The natural productions of the countries inhabited by the Polar race being few, and the conveniences of life difficult to be procured, all their efforts and study are directed to the supply of their most urgent wants, the incessant recurrence of which leaves them no leisure for the improvement of their minds. Their manners, therefore, are as uncultivated as their appearance is uncouth. The tallest among them seldom exceed the height of five feet, and many are not more than four. They are of disagreeable appearance, having broad faces, with short flat noses, eyes of a yellowish brown, high cheek-bones, thick lips, and in general, a weak and effeminate voice. They have large heads, lank black hair, and dark-brown complexions.

The resemblance of manners among these northern tribes is not less remarkable than their similarity in stature, complexion, and features. They are extremely ignorant, and have few religious ideas. Being totally unacquainted with the arts of civilized life, they covet none of its conveniences or luxuries; but, with the exception of the Greenlanders, are immoderately fond of tobacco and spirituous liquors, which they procure from their southern neighbours in exchange for the furs of various animals, the hunting of which is one of their chief employments.

Though these people are strangers to every art and science, and appear to be incapable of any vigorous efforts either of body or mind, they nevertheless display considerable ingenuity when stimulated by necessity, as well as great strength, activity, and courage, when difficulties or dangers call for the occasional exercise of those qualities.

Providence, while withholding from these poor people many blessings enjoyed by the inhabitants of other regions, has given them a contented disposition; and so strongly are they attached to their native land, consisting in general of immense tracts of mountains and morasses, that they cannot reconcile themselves to any other situation.

QUESTIONS.

What are the countries inhabited by the Polar race?
Which are the principal nations of this race?
What is their appearance?
What is their complexion?
How are they chiefly employed?

KAMTSCHATDALES.

ESQUIMAUX.

Lesson XI. *The Mongol Race.*

The second great variety of the human species is the Mongol race, to which belong most of the people we call Tartars; as the Mongols, the Mantchews, the Calmucks. The country called Tartary comprises the whole of Central Asia, and is peopled by numerous tribes, which, though somewhat different in features and complexion, retain those particular traits of resemblance by which the whole race is distinguished from any other nation. All the Tartars have the face broad and wrinkled, even in youth; the lower part narrow, and inclining to a point at the chin. They have a flat forehead, a short flat nose, high cheek-bones, thick eyebrows, small oblique eyes, thick lips, and a colour more or less yellow. They are of middle stature, strong, robust, and healthy.

All the tribes of Tartars lead a wandering life. They build no towns, neither do they cultivate the ground, except for the purpose of raising a grain called millet; and they live in tents covered with the skins of animals. Their chief food is horses' flesh, which they often eat raw, and their usual drink is mares' milk. Their principal wealth consists in their horses, in the management and care of which great part of their time is employed. They practise robbery as a profession, and think it neither criminal nor dishonourable, provided that it be exercised on people of a different tribe. Some of the Tartars are Mohammedans; some are followers of a mock deity called the Grand Lama, who is worshipped as a divinity; while others of these wandering tribes appear to have scarcely any religious ideas beyond a general belief in a Supreme Being.

In the Mongol race are included the natives of China and Japan. The features and the general cast of countenance of these people show that they are of Tartar origin; whilst the difference in their manners, customs, and habits of life, is the effect of a certain degree of civilization and of the moral influence of political institutions.

The Chinese are a proud and independent race of people, who enjoy within their own terri-

tories all the necessaries and conveniences, and most of the luxuries, of life. They are very ingenious; and to them is attributed the invention of the mariner's compass, the manufacture of gunpowder, porcelain, &c.

The Japanese are a brave and clever people, but suspicious and revengeful; they never quit their country, and allow of very little intercourse with foreigners; although many attempts have lately been made by Europeans to open a trade with them, they have not succeeded.

Travellers are of opinion, that not only the Tartars, the Chinese, and the Japanese, but all the inhabitants of India beyond the river Ganges, have one common origin, and belong to the same race. The natives of the South Sea Islands and of the great continent of New Holland are also supposed to be of similar origin, although those who live in the hottest of the islands are almost as black as negroes; such, among others, are the Papous of New Guinea.

QUESTIONS.

What nations belong to the Mongol race?
Where is Tartary situated?
What are the distinguishing features of the Tartars?
What kind of life do they lead?
What are their dwellings?
What is their chief food?
What does their chief property consist of?
What is the character of the Chinese?—Of the Japanese?
What other nations besides the Tartars belong to the Mongol race?

Lesson XII. *The Negro Race.*

The Negroes, or Blacks, form the third and most distinct race of mankind. They inhabit all the coast of South Africa, from the river Senegal to the Red Sea. Indeed, it is believed that the interior also of that extensive tract of country is occupied by the black-complexioned race, with the exception of Abyssinia, the inhabitants of which are olive-coloured.

The Negroes are not more remarkable for their jet-black colour, than for the delicate smoothness of their skin. They have deep hazel eyes, a short flat nose, thick lips, long muzzle, prominent cheek-bones, beautifully white teeth, and crisp, short, woolly hair. The natives of Guinea are accounted the ugliest of the black tribes, and

those of Congo and Mozambique, the handsomest. Further southward, they become a little paler, and take the name of Caffres. Almost all the inhabitants of the east coast of Africa belong to this variety. The Hottentots, found in the most southern point, form another subdivision. They have cheek-bones so prominent that the face appears almost triangular, and their colour is a brown olive.

It was among these black nations that the people of Europe for several centuries purchased human beings, whom they carried away to be employed as slaves in the cultivation of the land in their American colonies. Great Britain was the first to discontinue this barbarous traffic, an example that has been at length followed by almost all civilized nations; and the English Parliament lately made a law for restoring all slaves living in the British dominions to their natural liberty within a certain number of years; which has now happily been effected.

QUESTIONS.

What are the countries inhabited by the Negroes?
What are they distinguished by?
Which are accounted the ugliest of the black tribes?
Which are the handsomest?
What nations in the southernmost part of Africa, though not quite black, belong to this variety?
For what purpose were slaves purchased by the Europeans among these black nations?
What country first gave up this dreadful trade?

AMERICAN INDIANS.

LESSON XIII. *The Red, or Copper-coloured Race.*

THE original natives of America form a fourth race, not less different in colour, than distinct in habitation, from the rest of mankind. All the savage tribes of that vast continent, with the exception of the Esquimaux already mentioned, are of a red or copper colour. In the Old World (that is, in Europe, Asia, and Africa) diversity of climate never fails to produce difference of complexion; but among the original tribes of America (called the New World, because it was not discovered by the Europeans till about three hundred and fifty years ago) that effect is not so perceptible; so that, among its various nations, there is scarcely any difference in colour, and less than might be expected in

the shape of the body and the features of the face. They have all high cheek-bones, small noses and eyes, thick, black, coarse hair, and remarkably thin beards. Both men and women paint their bodies and their faces; and among some of the tribes, fashion and taste in this method of decoration seem to be as much studied as in the various modes of dress among civilized nations. They live in wigwams, or low houses built with the twigs of trees.

Towards the southern point of America is found the tallest race of men in the world, called Patagonians. Early travellers represented them as of gigantic stature; but, according to later observations, their average height is between six and seven feet.

The native Americans are said to be less ready to face danger than the people of Europe; but no sooner does it appear unavoidable, than their courage is excited to the highest pitch. They are then ready to suffer or to inflict the most cruel tortures; and, either through native fortitude, or the influence of custom and education, they display the utmost composure amidst the greatest agonies. To conquered enemies they are invariably cruel, though kind and just to persons of their own tribe. Their ancient implements of war were the hatchet, and bows and

arrows; but where they have the opportunity, they generally procure fire-arms from the Europeans, and soon become expert in their use.

The Indians still occupy the greater part of America. For the most part they continue a distinct people, and retain their savage customs; but in some instances they have in some measure mingled with the white population.

Though many of the tribes of the Americans are equal in stature to the Europeans, they are not so muscular and strong, probably owing to the climate, together with the scantiness or the bad quality of their food. They lead a wandering life, subsisting on the animals which they kill in hunting, on fish, and on wild fruits and roots.

Patience and sincerity, indolence and rapacity, warm attachment to friends, and implacable hatred to enemies, mark the character of the savage in every part of the world.

QUESTIONS.

Where is the Red, or copper-coloured race found?

Is there much difference in colour, shape, and features among the various savage nations of America?

What are the general characters of the face?

What peculiar method have they of adorning their bodies?

Where do we meet with the tallest race of men in the world?

What are they called?

What is their average height?

What are the principal features in the moral character of the native Americans?

To what cause is their inferiority in strength to Europeans attributable?

What kind of life do they lead?

How do they subsist?

What marks the character of the savage?

Lesson XIV. *The White Race.*

The fifth and last great division of mankind is the White race, with oval face, long hair, and pointed nose. It comprehends the people of Europe, and some of the adjacent countries; for instance, the Turks, the Circassians, and other tribes about Mount Caucasus, the Persians, the natives of Hindostan, the Arabians, the Moors, who inhabit the north of Africa, and the Abyssinians, as well as the Jews.

In countries of such extent, there is considerable variety of complexion and countenance: in the north, the people are larger and fairer, with light hair and blue eyes; whereas, in the south they are dark, often very brown, and have black hair and eyes. There is an intermixture of these colours in the more temperate regions. The White race naturally appears to us to be the

most comely of all the varieties, and undoubtedly it surpasses all the others in activity and enterprise, in the cultivation of the arts and sciences, and in all other matters connected with the progress of civilization. In consequence, this race has established itself in almost every part of the globe, and has everywhere gained a decided superiority over all the rest. Indeed, all the great events in history are connected with the movements of this race, who have transmitted to us all that we know about the other inhabitants of the world.

Climate, no doubt, has great influence on the human complexion: yet the mode of life and the general tendency in children to resemble their parents contribute not a little to effects which are often attributed to the former cause alone. The Circassians, for instance, the handsomest people in the world, live under the same climate as the Tartars, who fall exceedingly short of the standard of European beauty; and the Abyssinians are olive-coloured, while they are almost surrounded by nations of the blackest hue.

QUESTIONS.

What are the personal characteristics of the White race?

What nations does it comprehend?

What differences are observable between the northern and the southern nations of this race?

Is the White race widely spread?

In what moral qualities does it surpass the other races?

What people are accounted the handsomest in the world?

In what respect do the people of Abyssinia differ from the surrounding African nations?

Lesson XV. *Savage, Pastoral, and Civilized Nations.*

Independently of the divisions into races of which we have just heard, all the nations of the world are arranged in three great classes, according to the degree of civilization that prevails among them. They are accordingly styled Savage Nations, Pastoral Nations, and Civilized Nations.

The first class, called Savage Nations, (such as the inhabitants of New Holland, the American Indians, and many others,) take no trouble to ensure a regular subsistence. They neither plant nor sow; they lay up no store of provisions; they give themselves no concern about the future, going in quest of food only when urged by hunger, and passing the rest of their time in indolence. Their sole employments, therefore, are hunting and fishing.

These people do not even dwell together in villages; have no fixed habitations, but only wretched huts, consisting of a few poles thrust into the ground, and covered with skins of animals, or only the large leaves of trees. Some even live in holes under the surface of the ground; and among these savage nations only a few families in general associate together. They

have no common head; but, in time of war, or on occasion of a great hunt, they choose a leader, whom they obey till the war or the hunt is over. Other nations, (such as the Arabs, and the Tartars,) called Pastoral Nations, or Nomades, from their wandering mode of life, have no fixed abodes, but only tents or huts, which they easily take down and set up again; but they are much more intelligent and less rude than the savage tribes, because they are engaged in rearing cattle—a pursuit which requires much more attention and skill than hunting. Their herds and flocks are their only wealth. They move about from place to place, and make a long stay only in situations where they meet with good pasturage.

In the South Sea Islands exists a race of people who may now be considered as partially civilized. When first discovered they were plunged in gross idolatry, but they displayed great readiness to profit by the visits of Europeans, and they have now happily made very considerable advances towards a state both of civilization and Christianity.

Really civilized Nations (such are all those of Europe) employ themselves, not only in rearing cattle, but also in agriculture and navigation, and in all kinds of arts and handicraft business.

They dwell together in communities, in permanent and commodious habitations, forming cities, towns, and villages. These communities consist of persons of various classes—namely, princes, nobility, gentry, citizens, farmers, artizans, and others, who follow all sorts of trades, professions, arts, and sciences.

Civilized nations live according to laws; that is to say, they have agreed among themselves what it shall be lawful or unlawful for each person to do; and all who wish to dwell among them must promise to obey these laws. To enforce this submission, even on the part of the most ignorant and the worst disposed, they select a certain number of intelligent and upright men, to cause obedience to be paid to the laws, and to punish offenders. These persons are called Magistrates.

In many states a single individual possesses a right to make laws and to appoint the magistrates. This person is called the Sovereign, or Monarch, and has the title of Emperor, King, Prince, or Duke. The countries which are under his government constitute his dominions. If no persons share this power with the ruler, as in Russia and Turkey, the form of government is styled a Despotic Monarchy; but if others have any share in making the laws, as is most

generally the case in Europe, it is then called a Limited Monarchy. A state in which there is no single person supreme, but all have a voice in making the laws by which they are governed, as is the case in the United States of America and in Switzerland, is called a Republic.

The form of Government subsisting in Great Britain is called a Mixed Government, because it partakes of the nature of both the kingly and the republican; for, on the one hand, it has a Sovereign for its head; and, on the other, the people assist, by their representatives, whom they send to Parliament, in making laws, and in controlling the disposal of the public money.

QUESTIONS.

What are the only employments of savage nations?
What sort of habitations do they construct?
Are they under any kind of government?
What sort of abodes have the pastoral, or wandering nations?
What pursuit are they engaged in?
How are the civilized nations employed?
What sort of habitations have they?
How are they governed?
What are those persons called whose duty it is to enforce obedience to the laws?
When one person is invested with the supreme authority, by what title is he known?
What are the countries under his government called?
What is a republic?
What is the form of government established in Great Britain?
Why is it called a mixed government?
What is the title of its head?
In what way have the people a share in the government?

THE ANIMAL, VEGETABLE, AND MINERAL KINGDOMS.

PART THE FIRST.

LESSON I. *Natural Objects in general.*

THE earth, the air, and the waters are all filled either with living or inanimate objects. The more we examine these, and the wider our knowledge of them extends, the more do we learn of the wisdom, the power, and the providential care of our Maker and Preserver.

The slightest attention will convince us that the same care has been bestowed on the structure of the most minute beings, as on that of the largest animal; and every step in the study of nature is full of interest and instruction. We cannot look anywhere without finding something to admire, something to astonish and delight us, and something to make us sensible of the goodness and bounty of God.

Some of these objects, such as man, beasts, birds, fishes, and insects, live and move, and are said to have *animal* life: others, as trees, plants, grain, flowers, and mosses, have also life, but it is life of a different kind, and called *vegetable* life: whilst others, as stones, chalk, coal, and earth,

have no life, and are therefore called *inanimate* objects,—that is, objects without life.

Everything which "lives and moves, and has a being," does so by the direct and mysterious laws of God, which we can neither understand nor imitate. These are called *Natural Objects*, or the "productions of nature;" terms by which we distinguish them from the works of man, which are called "productions of art."

The productions of nature are not alike in all countries, as their growth and existence depend in some measure on climate. Some countries are very hot all the year round, others are very cold, and others neither very hot nor very cold, but temperate. This difference makes the soil vary in its productiveness. Many useful things, therefore, which grow plentifully in one country, are not found in another; and this has led the people of different countries to buy and sell with each other, exchanging such articles as they do not want among themselves, for others which they stand in need of. By this means the productions of nature are spread over the whole world, for the comfort and convenience of man.

QUESTIONS.

With what are the earth, the air, and the waters filled?
Which of these objects have animal life?
Is there any other kind of life?
What objects have no life, and what are they called?
Are all countries equally productive?
How is this accounted for?

LESSON II. *The Three Kingdoms of Nature.*

NATURALISTS have arranged all objects in or on the air, the earth, or the waters, in what they style "the three Kingdoms of Nature." These are, first, the *Animal Kingdom;* second, the *Vegetable Kingdom;* and, third, the *Mineral Kingdom.*

The Animal Kingdom is so named because everything which it includes possesses *animal life,* that is, it can move and feel. This kingdom is already known to contain upwards of one hundred and twenty-five thousand different species, or kinds of animals. The forms and sizes of these animals are exceedingly varied; and they are found in great abundance on the earth, in the air, and in the waters. Some are so small as to require the aid of a microscope to discover them; some, as the elephant and the whale, excite our wonder by their magnitude and strength; whilst others delight us by the beauty of their colours, or the elegance of their shapes.

The Vegetable Kingdom, which includes trees, plants, shrubs, grasses, and mosses, is so named from the objects embraced by it having what is termed *vegetable life,* that is, they do live, but can neither move nor feel. A plant lives and

dies in the very same place it first took root, and shows no signs of being sensible to injury, as animals are. This kingdom is known to contain one hundred thousand different species.

The Mineral Kingdom includes all those natural objects which have *no life*, such as stones, earths, and metals. This kingdom contains about two hundred and seventy species.

We are thus already acquainted with upwards of two hundred and twenty-five thousand different kinds of objects, the whole of which come under the general term, "Productions of Nature," and fall into one of the great divisions or kingdoms.

These kingdoms are essential one to another, for without the vegetable world animals could not live, nor the vegetable without the mineral. Every animal is designed for some certain use, so is every vegetable or mineral, however insignificant it may appear to us; and this should make us careful to examine everything that comes before us, as we shall never fail to find much that will both please and instruct us.

QUESTIONS.

Mention the three kingdoms of nature.
What is animal life?
In what does vegetable life differ from animal life?
What does the mineral kingdom include?
Are the three kingdoms independent of each other?
What do we learn from everything having some use?

LESSON III. *Productions of Hot Countries.*

THE animal, the vegetable, and the mineral kingdoms, as we have heard, are found to differ in different countries. The wisdom of God has ordained that every climate should produce those objects which are most necessary for the comfort and convenience of its inhabitants. Thus we find that hot countries, which have no winter, abound in juicy and refreshing fruits. The cocoa-nut, the olive, the date, the melon, the orange, and the pine-apple, grow luxuriantly, and afford grateful and refreshing food. A few dates and a crust of bread are the dinner of the

Arab, and the bread-fruit-tree furnishes the simple and healthy repast of the South Sea islander.

The animal kingdom, in hot countries, contains some of the largest species that live on land. The elephant has its native home there, and in its wild state is found from ten to twelve feet high, thirteen or fourteen feet long, and often weighing six or seven thousand pounds. Even with this enormous bulk and weight it is an animal of quick motions, and will travel seventy or eighty miles a-day. The camel, so beautifully called "the ship of the desert," is capable of enduring intense heat, and, though burdened with a load of six hundred pounds, can perform a journey of sixty miles in ten hours. Many dry and sterile regions of the earth would have been impassable by beasts of burden, but for this docile and patient animal. By a singular and wonderful provision, it is enabled to travel many days without drinking, over burning sands and under a scorching sun, where any other creature would perish.

The ostrich, one of the largest birds, also dwells in hot countries. It cannot fly, as its wings are very short, and have nothing but soft, downy feathers upon them. However, it can run much faster than the fleetest horse, and would soon outstrip its pursuers, who hunt it

for the sake of its feathers, were it to go straight forward; but it runs from side to side, and is soon caught. The eggs of the ostrich are very large; one egg being a sufficient meal for three persons. Some of the largest snakes, as the boa constrictor, have also their haunts in hot countries.

The people inhabiting warm countries are not so strong or so active as the natives of temperate regions. The soil is, however, so fertile, that the finest fruits and grain are produced with little labour; and the vegetable productions are so numerous, and ripen their fruit at such different periods of the year, that the inhabitants are never without a supply of fresh and wholesome food. In these countries, where the inhabitants are least able to bear thick and heavy garments, the cotton-tree and the silk-worm provide them with light materials, admirably fitted for their clothing.

QUESTIONS.

What kind of fruits are chiefly found in hot countries?
How is this accounted for?
Mention the diet of the Arab and the South Sea islander.
What large animals live in hot countries?
To what size does the elephant grow?
How far can it travel in a day?
What renders the camel so valuable in hot and dry regions?
What peculiarity has the ostrich?
Why is it so readily caught by the hunter?
What appearance has the country in hot climates?
How are the people furnished with suitable clothing?

Lesson IV. *Productions of Cold Countries.*

The animal and vegetable kingdoms in cold countries have a very different appearance to that which they have in very hot ones. The care of Almighty God is, however, seen alike in both; and their productions are equally fitted to the comforts and the wants of the inhabitants.

The soil of very cold countries cannot yield much. The summer is so short, that fruits and grain do not ripen; and the few vegetables which flourish there, are chiefly lichens, moss, and stunted trees. The natives, therefore, do not

seek their support from the vegetable kingdom, but live almost entirely on the flesh of fish, water-fowl, and wild animals. The latter exist in great plenty, and many of them are covered with thick fur, which serves as a warm clothing against the extreme cold.

The rein-deer is an animal peculiar to cold countries, especially Lapland. It supplies the inhabitants with almost everything which we obtain from the horse, the ox, and the sheep, and provides for the greatest part of their wants. Their skins are made into shoes, bedding, tent-covers, and dress; their horns into various kinds of vessels; their bones into knives, spoons, and needles; and their sinews into cord and thread. Very little trouble is required to keep the rein-deer, as it feeds chiefly on leaves and mosses, which it seeks for itself, by scraping away with its hoofs and horns the snow that generally covers the ground. It is the companion of its owner and his family; and it can perform a journey of more than a hundred miles in twenty successive hours. The female gives a rich milk, and the flesh forms excellent food.

In other countries, as Kamtschatka, in the extreme part of Asia, the dog is almost equally useful, and gives striking proofs of sagacity and docility. He serves for drawing sledges over the

frozen snow, and has been known to travel nearly a hundred miles a-day. He braves the severest snow-storms, and when his master has lost his way, he frequently regains the track by his own sagacity. The flesh of the dog in these countries is considered nourishing food; but so great is his value, that he is seldom killed, unless his owner is severely pressed by hunger.

In Greenland and some other very cold countries, the whale and the seal form a great part of the means of sustenance of the people. The fat, or blubber, according to the accounts of travellers, is eaten by them with much greediness, and the refuse supplies them with fuel for their fires, and oil for their lamps, during their long and dreary winter.

The inhabitants of these northern regions, as we have already said, are of small size, but they are strong and active. Their dress, which is composed principally of skins covered with fur, is very warm, and often very valuable, the fur being an important article of commerce.

QUESTIONS.

Are many vegetable productions found in cold countries?
What is the principal diet of the people in northern regions?
Describe some of the uses of the rein-deer.
What other animal is very valuable in some cold countries?
Does the dog show signs of sagacity in these situations?
Mention an example of this.
What is blubber?—to what uses is it applied?

LESSON V. *Productions of Temperate Countries.*

MANY of the most useful and valuable objects in the three Kingdoms of Nature are found in temperate countries, where the climate is neither very hot nor very cold. We, in England, live in a temperate country, and have spring, summer, autumn, and winter, in regular and equal succession. The weather in temperate countries is changeable, but the changes are in the highest degree favourable to the fertility of the soil.

The animal kingdom, in these countries, embraces those creatures which are the most serviceable to man. The horse, the ox, and the sheep, are found in their most perfect state, and are used for draught, for riding, for food, or for clothing; while the different sorts of grain, which serve for our own support, and for that of

our domestic animals, are more abundant than in any other part of the world. In very cold countries, none of these animals can live. The horse, no further north than the Zetland Islands, is reduced to a very diminutive size, being scarcely so large as the smallest of our ponies, and soon becoming old and useless; whilst, on the other hand, in very hot countries, the cow loses some of her most valuable properties, and the wool of the sheep is deprived of its fleecy softness, and is converted into hair.

The productions of the vegetable kingdom, in temperate countries, are much more varied than in other situations. The wisdom of God has so ordered, that many of the most useful plants, which grow in other climates, should also flourish here. A much greater number of valuable vegetables are therefore cultivated amongst us than elsewhere. Wheat, the potato, many of our richest fruits, and most of the ornamental shrubs which adorn our gardens and shrubberies, have been introduced from warm countries. And our forests, though wanting the magnificence and grandeur of those in hot climates, abound with trees, such as the oak, the ash, the elm, and the beech, which yield useful timber.

The mineral kingdom is peculiarly rich in temperate regions, where the climate is also

favourable for the labour necessary to make its stores fit for use. Coal, iron, tin, lead, copper, and other minerals essential to arts and manufactures, and to the comforts of life, are found in great abundance. These form valuable articles of commerce, as they are useful to mankind in every part of the world.

The inhabitants of temperate countries live on animal and vegetable food in almost equal quantities. In this respect they differ from the natives of both very hot and very cold regions. People in the latter climate, it has been already said, eat only animal food; and in warm climates very little but vegetable food is consumed. Thus, we find that the productions of nature are fitted, in every country and in every climate, to the peculiar wants and condition of their inhabitants; and thus, wherever we look, we find cause to admire the wisdom, and to love the goodness, of the Creator of all things.

QUESTIONS.

What kind of climate has our country?
What good effects arise from the changeableness of the weather?
What animals are found in the greatest perfection in temperate countries?
Are the cow and the sheep as valuable in hot as in temperate countries?
Do many useful vegetables grow in temperate climates?
What mineral productions are found very plentifully?
Why are these valuable articles of commerce?
In what respect does the food of the natives of temperate climates differ from that in hot and cold countries?

Lesson VI. *Of Animals in general.*

All animals, whatever, whether living upon the earth, in the sea, or in the air, have been by recent naturalists arranged in four great divisions, called Vertebrata, Mollusca, Articulata, and Radiata; the first including all animals provided with a backbone, and the others all creatures which have no regular skeleton or bony system. Quadrupeds, birds, reptiles, and fish are included in the first division; soft-bodied animals, as oysters and snails, compose the second; flies, spiders, leeches, &c., the third; and the starfish, the coral insect, animalcules, &c., the fourth. Each division contains several classes, and we shall separately describe those of the division Vertebrata, but the remaining classes cannot be made intelligible to young readers in narrow limits, and a very general sketch of them must therefore suffice.

Every animal has a stomach, that is, a cavity in some part of its body, into which food is received, and which there undergoes a process called digestion. This is one great mark of distinction between animals and vegetables, as these last have nothing whatever in the shape of a stomach.

No animal but man possesses reason. God has, however, given to other creatures *instinct*,

by which they are enabled to provide for all their wants with unerring certainty.

A particular kind of spider, which makes itself a house in holes in the ground, shuts up the entrance by means of a door composed of particles of soil, fastened together by threads of silk. This door is held by a silken hinge to the opening at the upper side, and is so nicely balanced, that when pushed up, it shuts itself by its own weight. The most wonderful examples of instinct are shown, however, by those animals which live together in great numbers, as the bee and the ant. These insects build themselves habitations of beautiful regularity, and full of commodious apartments.

The modes which some animals have of defending themselves afford singular proofs of the care taken for their preservation. Horses have been known, when attacked by a wolf, to range themselves in a circle with their heads close together, and to defend themselves by kicking out with their hind legs; oxen use their horns for the same purpose, and the hedge-hog erects its prickles. Some creatures which live in water, make it muddy when in danger, and the cuttle-fish throws out a black, inky fluid, and thus hides itself, and escapes pursuit. Others, particularly amongst insects, feign to be dead. The

dor-beetle, which is so commonly found humming about, will, when it is caught, stretch out its legs quite stiff, and lie perfectly motionless, as long as there appears to be any danger.

The force of instinct is also very strongly shown by the mode in which many birds build their nests. Their eggs and young being much exposed to danger, the greatest ingenuity is displayed in guarding them against it. Some build in thick bushes, others in the clefts of rocks; the martin burrows in sand; the starling covers her nest with thorns; the spotted woodpecker and the nuthatch build in hollow trees, taking the greatest pains to fill up part of the entrance with clay; and many birds, as the grosbeak, and others, in countries abounding with snakes, which are very fond of nestlings, suspend their nests from the extremities of the most delicate twigs, and enter them through a narrow funnel-shaped passage from below.

QUESTIONS.

In how many great divisions has the animal kingdom been arranged?

Name them.

What is it that forms one great distinction between animals and vegetables?

What has been given to animals in place of reason?

Name some of the effects of instinct, as in the spider, the bee, and the ant.

How do horses and oxen defend themselves?

By what means does the cuttle-fish escape pursuit?

What creature feigns to be dead when it is in danger?

Mention a few of the modes in which birds build their nests.

LESSON VII. *On the Senses of Animals.*

GREAT differences are found to exist amongst animals, as to the quickness and extent of range of their senses. The eye of the eagle is very acute; and he can see his prey upon the ground or in the water when he is soaring at immense heights in the air. Such animals as feed on carrion scent a carcase at great distances; and will find it even when very carefully concealed. That "household depredator," the mouse, has also a keen smell; and may be allured from its most secret and distant haunts by a bit of toasted cheese.

The senses of the dog seem to be very acute. Led by smell, he can find his way home from great distances, and trace his master through a crowded street. All his sensations indeed appear keen. He is the only animal which has followed man through every region of the earth. So strong

are his feelings of attachment, that instances have been known in which he has pined and died when separated from his master. The horse, too, obeys cheerfully the voice of his driver; the elephant pays willing obedience to the directions of his keeper; and the camel bends to the earth to receive his load.

There can be no doubt but that the possession of a very nice sense of taste and smell is the cause which enables animals to select their food. The great naturalist Linnæus informs us that the larger horned cattle, such as cows, will eat only about three hundred kinds of plants out of the two hundred thousand which the vegetable kingdom contains. They leave all the rest untouched, however beautiful and nutritious they may be. The horse feeds upon two hundred and sixty-two species; whilst the hog, still more choice in its selection in a wild state, eats only of seventy-two, and will not taste any other. Caterpillars show the same capacity of selection; for if thirty different kinds of leaves are put in their way, they will, perhaps, touch one only out of the whole number.

Thus in a pasture-field, some places may be seen cropped quite bare, and others left untouched, but as the tastes of animals vary, those plants which are refused by one species are eaten

by another. Some plants, too, which are poisonous to one creature, are eaten greedily, and without injury, by others. The horse, the goat, and the sheep, feed upon the water-hemlock, which is poisonous to the cow. Bees make wholesome honey from the juices of plants which are hurtful to man.

The sense of touch varies greatly in different animals. Man uses his hands, feet, tongue, and lips, for feeling; monkeys do the same. In other instances, this sense is chiefly seated in the snout, the proboscis or lips. Birds use their feet and bills for touching. In snipes and ducks, which have long bills, and which seek their food among mud, the extremities of these are soft, and have a very delicate sense of touch.

The hearing of most animals is remarkably acute: and if we watch the motions of birds and other creatures, we may soon be convinced that they are sensible of many sounds which we do not hear.

QUESTIONS.

For what is the eagle remarkable?
What kind of animals smell out their food at great distances?
Are the senses of the dog very acute?
Mention some proofs of this.
What is it that guides animals in their selection of food?
How many kinds of plants are eaten by the cow?
How many by the horse and the hog?
What plant poisons the cow and not the horse, the goat, and the sheep?
What parts are chiefly used for feeling, by different animals?
Do animals hear quickly?

LESSON VIII. *Clothing of Animals.*

THE care of a beneficent Creator is beautifully seen, in the clothing with which He has provided his creatures. This varies greatly in different species, and in the same species, according as the climate in which it lives is hot or cold; thus the dogs and the sheep of Africa and India, which are very hot countries, have so little wool upon them that they may be said to be naked; whilst the Esquimaux dog, and the Iceland sheep, where the climate is very cold, are covered with long thick fur. The covering of swine, in hot regions, consists of nothing but bristles; in colder districts, however, there is, in addition to these, a quantity of fine short wool next the skin.

The same variations are seen amongst our own domestic animals. The hair upon horses grows longer and thicker as winter approaches,

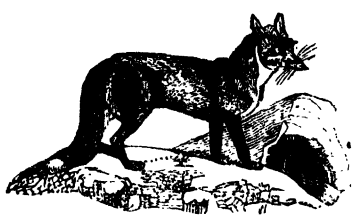
and thins and falls off in the spring: this is called their *winter-coating*, and preserves them from the cold. The same change takes place with cows and sheep. Those animals which are sought after on account of their *furs*, as the beaver, the fox, the hare, the rabbit, and others, are never hunted during the summer, because the fur is then thin and short, and of little value. As soon, however, as winter sets in, the fur *ripens*, as it is called, and rapidly increases in quantity and length.

Not only does the clothing of animals vary in quantity, according to climate and season, but, in many cases, it also changes its colour. The Arctic fox, during the mild weather, is of a bluish-gray tint, but it becomes white during the severe cold of winter. The Alpine hare, which inhabits the mountains of the northern part of Great Britain, has a coat of tawny-gray for its summer dress, but in winter it changes to a snowy whiteness. A similar variation takes place with the ermine, whose fur, from a pale reddish-brown, changes to a beautiful white. This alteration in colour, like the alteration in quantity, is a wise and beneficent provision of the Creator, to preserve animals from the effects of extreme cold, and it also assists to conceal them from the pursuit of their enemies.

The colour of the plumage of birds, like that of the hair of animals, changes with the season in many instances. The Ptarmigan, or white grouse, during the summer, has feathers of an ash-colour, mottled with dark spots and bars; but, as the cold weather comes on, the dark spots disappear, and its plumage is left of a pure white: in spring, the ashy colour returns. The guillemot, a water-bird, which frequents our coasts during the summer, is black, excepting a single white spot on its wings. In the winter the bird becomes of a dusky-white colour; and when seen in situations still colder, it is perfectly white.

QUESTIONS.

What difference is found amongst animals as to their clothing?
Name some of the examples mentioned.
What change is observable in the horse in summer and winter?
Why are animals which yield *furs* sought for only in winter?
What other change takes place in the clothing of animals?
Mention some animals which become white.
Is the same change observed amongst birds?
Name some instances.



LESSON IX. *Sleep, and the Winter Sleep of Animals.*

OTHER animals have, like man, times of action and of repose: and, when fatigued, they seek a safe and convenient resting-place. Some are exceedingly watchful during sleep, and appear scarcely to shut their eyes, as the hare and the chamois. Cats, owls, and most beasts of prey, pass the day partly in sleep, and seek their food during the night.

The attention bestowed by Almighty God upon the works of His hand, is very forcibly shown by the *torpid* state in which many animals pass certain portions of the year. Those which have this peculiarity, are called *Hybernating;* and, during the winter months, in temperate countries, and the dry seasons in hot ones, they fall into a deep sleep, and remain motionless for weeks, and sometimes for months. They are, by this singular means, preserved from being destroyed by cold, or from perishing from want of food, in seasons when it would have been impossible for them to have procured it.

Some of these hybernating animals, towards the end of autumn, prepare for themselves, with great labour and skill, a winter-house, and store it with provisions. The hamster, a very common

animal in Switzerland and Germany, makes itself an extensive habitation underground; and in this it shuts itself up, first closing and fortifying all the openings. Here, as the cold weather advances, it feeds upon its stores, and finally becomes torpid; in this state it remains till the warmth of spring revives it, and fresh food can be found. The marmot burrows a similar house for itself; but it lays up no provision, as it becomes torpid at once, and never wakens till late in the spring.

Bats retire to caves, the hollows of old trees, or to the chimneys of uninhabited houses; and in these situations may be found hanging in clusters. The hedge-hog rolls itself up in leaves and dried grass, and conceals itself in hedges; frogs congregate at the bottom of ponds; lizards hide themselves in the clefts of rocks; spiders wrap themselves up in their webs; the common house-fly may always be found in some sheltered corner; and snails fasten themselves to crevices in old walls and similar places.

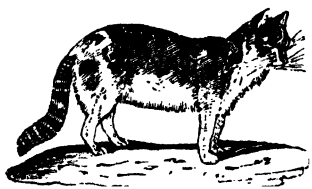
Several hybernating animals occasionally awake if a few fine days occur during the cold season. Instinct has, in these cases, taught them to lay up provisions, such as nuts, acorns, and other things; these are either enclosed in their dwelling, as by the hamster, or placed somewhere con-

veniently near. That beautiful little creature, the dormouse, may sometimes, on a mild day, be seen stealing from its nest, which is warmly lined, and secured against wet, to its granary under the root of some old thorn, or some secret crevice not far off.

Animals that pass the winter in a torpid state, if their dormitory is broken open, are generally found cold to the touch, and they appear to be almost dead. They also become much lighter during their torpidity, and when they awake, in the spring, are very thin.

QUESTIONS.

What animals are very watchful during sleep?
In what manner do some animals spend the winter months?
What name is given to them in consequence?
How does the hamster prepare its winter-house?
Mention some other examples of hybernating animals.
Do all these animals sleep during the whole winter?
How are they preserved from want of food when they awake in winter?
Mention one example.
What is remarkable about these torpid animals?
What change takes place during their torpidity?



Lesson X. *Migration of Animals—Birds of Passage.*

There is another very curious proof of the instinct of animals, and of their Creator's care for their preservation: and this is their *migrations.* This signifies that, at certain times, they remove from one situation to another—often to very great distances; crossing wide seas, and passing over entire countries: one kind of bat being known to live here during the summer and to remove into Italy during the winter.

There are but few quadrupeds which migrate very far. These rather remove from one part of the same country to another, according to the seasons. Some kinds of deer, however, in northern regions, change their residence in summer and in winter, and travel considerable distances.

Many birds migrate, and are hence called *birds of passage.* We are told in the Bible, that "the stork in the heaven knoweth her appointed times; and the turtle and the crane and the swallow observe the time of their coming." The regularity with which these creatures depart from, and return to us, is very surprising. The same pair of swallows have been known to occupy, for several successive years, the same nest, and to twitter as old friends, at the same window-sill;

yet these, during their absence, must have passed their time on the shores of Africa.

That most delicious warbler, the nightingale, which spends the summer with us, removes, at the end of autumn, into Egypt; and the yellow wagtail leaves us to winter in Senegal. These birds are so constituted as to be unable to bear the coldness of our winter. During the summer our hedge-rows and coppices are filled with "feathered choristers," busily engaged in rearing their young; but no sooner is this effected, and the cold winds of autumn begin to blow, than they wing their way to more genial climates, again to delight us by their re-appearance, in spring, as the harbingers of our finest seasons. These birds are called *summer* birds of passage; it is God who teaches them their appointed times of coming and going, and who guides them in their long journeys.

There are other migratory birds, which spend the winter with us, and not the summer. These are called *winter* birds of passage; and are chiefly water-fowl, that are driven from more northern regions by the freezing of the creeks, lakes, and marshes. These leave us in the spring, when the waters are again open, and breed while they are absent; generally retiring to Norway or Lapland. Such birds as feed

in the night, as the woodcock, perform their migration by night; and others, that seek their food during the day, fly during daylight, and rest at night.

Most birds, when preparing to migrate, assemble together in great flocks. Thus we may see clouds of swallows wheeling about in the air, in September, as if they were trying their strength of wing before their final departure. Woodcocks, turtle-doves, wild-geese, and shear-waters do the same at other seasons, and are always seen travelling in companies.

When it is asked how birds can make such long journeys, the answer is simple—The rate at which they fly is astonishingly rapid, and has been calculated at from fifty to seventy miles an hour. A day's journey would carry them, therefore, four or five hundred miles; and, as they are capable of remaining for many hours without food, they thus easily pass from one country to another.

QUESTIONS.

What is the meaning of migration?
Do many of the quadrupeds migrate?
Do many birds migrate?
What name is given to them?
What is remarkable about the return of the swallow?
Where does it pass the winter?
Where do the nightingale and wagtail winter?
Do summer birds of passage rear their young with us?
What kind of birds are chiefly the winter birds of passage?
Do these breed with us?
At what rate do birds of passage fly?

Lesson XI. *Mammalia.*

The four great divisions of which the reader has already been told, are subdivided into classes and orders. The Vertebrata are arranged in the four classes of Mammalia, Birds, Reptiles, and Fishes.

The Mammalia suckle their young, till they are able to provide themselves with food, whence their name. They have also been called *viviparous* animals, because their young are born alive, and not inclosed in an egg.

The Mammalia, generally speaking, are quadrupeds, that is, four-legged animals: man has however two legs, and is hence called a *biped;* and the monkey tribe, instead of four feet, have four hands, and are called *quadrumanous,* or four-handed animals.

The greatest part of the Mammalia live upon the ground. There are, however, some, as apes, squirrels, and the sloth, which spend most of their time in trees. A few, as the mole and the hamster, dwell chiefly underground; others, as the beaver, the water-rat, the white bear, and the seal, are sometimes on land, and sometimes in the water, and a few live entirely in the sea.

Such of these animals as live partly on land and partly in water, have their fingers and toes

connected by a membrane or web, which is of great use to them in swimming. Bats have the long finger-like toes of their fore-feet united by a delicate web, which, when the toes are opened, expands and forms wings, and enables the creature to fly. Bats are the only Mammalia which have this power, though there is one species of squirrel, called the flying-squirrel, which can support itself for considerable distances through the air, when springing from tree to tree.

Many animals in this class have horny and undivided hoofs, as the horse and the ass; others have divided or cloven feet, as the sheep and the cow. Most of them walk on their toes, only a very few species placing the sole of the foot on the ground.

The bodies of most of the Mammalia are covered with hair. Some have it scattered very thinly over the body, as the elephant and the rhinoceros: others are very thickly covered, as the sheep. This hair varies greatly, both in length and colour. In some species it is curled and woolly, as in many varieties of dogs and sheep; in others it is stiff and straight, forming bristles; and sometimes it is in the shape of strong and pointed spines, as in the hedgehog and the porcupine. There are some animals which have the hair on the neck long and flowing, as the

horse and the lion, in which cases it is called a mane; and in others hair grows long under the chin, and is then called a beard, as in the goat.

Many of the Mammalia have claws and teeth to defend themselves; others are furnished with horns. Those of the stag are branched, and termed antlers. They are shed or cast off every year, and replaced by new ones, which are at first very soft and tender.

Some animals of this class, as the ape, the seal, and the hamster, are furnished with cheek-pouches, or little bags placed on each side the lower-jaw. These they use as pockets, and carry provisions in them: others have a pouch or bag on the belly, which is large enough for their young to creep in when feeding, or when threatened with danger. This peculiarity is seen in the kangaroo and the opossum.

QUESTIONS.

What shape have the mammalia in general?
In what respect does man differ from the rest?
Are monkeys four-footed animals?
What name is applied to them?
Mention the different situations in which the mammalia live.
What peculiarity have creatures which live partly on land and partly in water?
Describe the wing of the bat.
Does any other animal of this class fly?
In what respect do the hoofs of horses and cows differ?
With what are the bodies of the mammalia generally covered?
What names are given to the hair when it grows long in certain situations?
What animals are furnished with cheek-pouches?

Lesson XII. *Mammalia of the Sea.*

Several of the Mammalia live entirely in the sea. Amongst these are the whale, the dolphin, and the narwhal. These animals, though living in water like fish, and having the same habits in general, bring forth their young alive, and suckle them, and in their internal structure closely resemble land animals.

The whale is the largest of all animals, and grows to a vast size, sometimes measuring eighty or ninety feet in length, nearly as many in circumference, and weighing from two to three hundred thousand pounds. The mouth of the whale is very large, and will contain a ship's boat full of men; the tongue fourteen or fifteen feet long, and seven or eight feet wide. Like the human being, the whale has lungs, and can only breathe by raising its head out of the water. On the top of the head are the nostrils, or blow-holes, through which the whale throws a moist vapour eighteen or twenty feet high, with a noise which may be heard at a great distance. Its tail is very large and powerful.

This immense creature, however, lives upon small sea animals, and is provided with a very curious apparatus for catching them. This is what is called whale-bone, and consists of nume-

rous plates, fixed to the top of the mouth, with a fringe growing from their lower edges. It is by means of this fringe that the whale is enabled to catch its prey, as it serves as a sort of sieve to entangle the small animals that are taken into its mouth. Its skin is very smooth, and looks almost like oiled silk, and beneath this is a thick coating of fat or blubber, which supplies us with train-oil. This kind of whale dwells in the frozen seas of the North. Another kind, which yields spermaceti and sperm oil, inhabits the South Seas. The seal also is valuable for its oil and skin.

Dolphins are often seen playing about ships in great numbers, gamboling backwards and forwards. When taken from the water they exhibit very brilliant changing colours, while dying.

The narwhal has originally two tusks: when full-grown it has but one, which is sometimes as long as the body, and is curiously twisted: from this peculiarity the narwhal is sometimes called the sea-unicorn.

QUESTIONS.

What mammalia live in the sea?
With what do whales supply us?
To what size does the whale grow?
Can you state any other particulars of the whale?
For what is the dolphin celebrated?
Why is the narwhal sometimes called the sea-unicorn?

Lesson XIII. *Utility of the Mammalia to Man.*

All the "productions of nature" are designed by their Divine Author to fulfil some wise and beneficial purpose. Amongst the rest, the Mammalia are especially useful to man; and serve for riding, for draught, for carrying burdens, and for cultivating the land. For these purposes the horse, the ass, the ox, the buffalo, the rein-deer, the elephant, the camel, the llama, and the dog, are willing servants. Man also finds his principal supply of food in this class of animals: the flesh of the ox, the sheep, the goat, the hog, the stag, the hare, and the rabbit, forming a nourishing and palatable diet. In some countries the flesh of the horse and the dog is much esteemed as food. The fat and the milk of mammalia also supply lard, butter, and cheese.

Besides these uses, many parts of animals are of the utmost importance to the comfort and convenience of man. He derives the greatest part of his clothing from their skins, their hair, and their wool. Many skins are prepared with the hair left upon them, and in this state are called furs. These are furnished chiefly by wild animals: as the fox, the hare, the beaver, the ermine, and the sable.

The fur of these, and the hair of the dog and the goat, are made into hats. That of cows and calves, and horses, is used for stuffing chairs, sofas, and mattresses, and for making hair-cloth, the finer sorts of which are sometimes used for clothing, and the coarser for packing valuable goods. The shining covering of chair-seats is made of horse-hair, and the hair of violin-bows is procured from the tails of horses. Camel-hair is used for making painters' brushes, and a stuff called camlet; and the hair of the Angora goat is manufactured into a yarn, from which various stuffs are woven. The wool of the sheep is, however, the most valuable, being spun and woven into cloth, shalloon, serge, baize, flannel, and stockings.

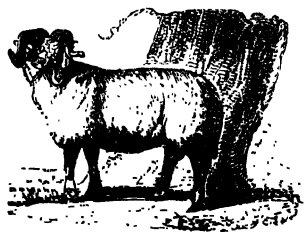
The most important use of the skins of animals is to make leather, by a process called tanning. This is the business of the tanner, who employs the skins of oxen, calves, sheep, deer, and goats. These are made into shoes and boots, and harness: they are also used for binding books; and the skins of wild boars and horses are used in making saddles.

Candles are made from the fat of oxen and sheep, and the whale and the seal furnish oil for burning in lamps. The bristles of the hog are made into brushes. The horns and teeth (espe-

cially elephants' teeth, or ivory,) and the bones of mammalia, are shaped by the turner into a variety of useful and ornamental articles; as knife-handles and combs; and glue is made by boiling down their bones, horns, and sinews. Catgut is prepared from the intestines, and the dung, laid upon the ground, serves as manure. In some countries, where there is little wood and no coal, dried dung forms the principal fuel of the inhabitants.

QUESTIONS.

What class of animals is particularly useful to man?
Mention some of the mammalia, and the uses they are of.
What animals supply us principally with food?
For what purposes are skins, hair, and wool used?
What are hats made of?
What is made from the hair of cows, calves, and horses?
From the wool of what animal are made flannels, baize, serge, and stockings?
What is leather, and what name is given to the process of making it?
For what purpose is leather chiefly used?
What are candles made from?
Are the horns, teeth, and bones of mammalia useful?
What is glue?



Lesson XIV. *Birds in General.*

Birds form the second class of the Vertebrata. They differ very widely from the Mammalia in their structure and appearance, and also in the mode of producing their young. They all lay eggs, and are hence called *Oviparous animals.* These eggs, on being incubated or sat upon, are hatched by the warmth of the mother, and in a certain time young birds are produced from them.

The form of birds is very graceful, and though a numerous class, they have a strong general resemblance to each other. All of them have two legs, two wings, a horny bill, and a body covered with feathers. They are found in every part of the world, and, like all other natural objects, afford striking proofs of the wisdom and care of their Creator. In very hot countries this class of creatures is seen fluttering amidst lofty forests, or gliding over the plains in brilliant and gorgeous colours, and of the most beautiful and delicate shapes. The parrots, the crested pheasant, that "floating gem," the humming-bird, and the superb bird of paradise, are very numerous. In very cold countries birds are much less numerous, and consist chiefly of water-

fowl. These seek their support in lakes and creeks of the sea, as the ground is almost continually frozen or covered with snow, and consequently does not yield any food. Temperate countries have a great variety of birds, as some from hotter climates spend the summer there, and others migrate from cold regions to pass the winter there. Many of the birds of these countries are also song-birds, and fill the hedge-rows and coppices with delightful music.

The vision of birds is in general very quick, and of very wide range. The swallow, which feeds on small insects, catches them when on the wing, and many of the rapid evolutions it makes are for the purpose of seizing a prey too minute to be seen by man. The hen, when surrounded with her brood, will detect a hawk at a distance far beyond our limit of sight; and the redstart, though perched on the top of a lofty tree, will dart to the ground, and with unerring aim seize upon the smallest insect.

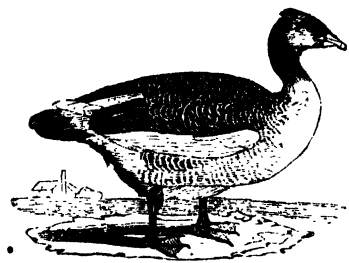
To guard the eyes of birds against mischief when flitting rapidly amidst thickets, and to screen them from the glare of the sun, a very wonderful provision has been made. This is called the *nictitating* or *winking membrane*, and is in the form of a half-transparent curtain, which

the bird can at pleasure draw over the eye, without obstructing the sight.

The *bill* or *beak* of birds serves all the purposes of teeth, with which they are not supplied. It is used for seizing and bruising their food, and as a sort of hand for carrying; it is also the instrument for cleaning and dressing their feathers, for building their nests, for defence, and in some instances, as in that of the parrot, for climbing.

QUESTIONS.

In what way do birds produce their young?
What are they called in consequence
What parts are common to all birds?
What birds are found in great numbers in hot countries?
What birds are plentiful in cold countries?
How is this accounted for?
Are birds numerous in temperate climates?
Are they song-birds?
Mention some instances of the quickness of sight in birds.
What guards their eyes?
For what purposes is the bill useful?



THE WILD GOOSE.

Lesson XV. *Structure of Birds—Wings, Lungs, Crop, Feathers, &c.*

The frame of birds is very beautifully adapted to their habits. Many of them pass a great portion of their time in the air, either in the pursuit of their prey or in sportive gambols; and in these we find every part of the body framed as lightly as possible. In order to enable them to glide easily along, all their feathers lie one way, pointing backwards, and folding over each other in regular order. No resistance is offered to their flight by this arrangement, whilst beneath these is a layer of soft down, which preserves them from cold, to the effects of which, but for this provision, they would have been much exposed.

The wings of birds are the means by which they support themselves: they contain the largest and strongest feathers, and, though made of very light materials, are moved by powerful muscles. These propel the birds forward with great rapidity, and enable them to sustain long flights during their migrations. Their bones also are exceedingly light and thin; and to make them still more buoyant, air cells, connected with their lungs, are extended almost over the whole

body. In the mammalia, the lungs are confined to the chest, but in birds they pass along the sides of the belly into the bones, and even into the pinions, or wing feathers. All these are filled when the bird breathes, and it is thus made almost as light as the air, and floats in it very easily and safely. Next to the wings, the largest feathers are in the tail, which is used as a kind of rudder, to guide and regulate the bird's motions when flying.

Birds have no teeth for masticating their food; therefore they either swallow it whole, or crush and tear it with their bills. Some of them, which feed principally upon grain, always swallow it without breaking; and in these the food does not pass at once into the proper stomach, or gizzard, as it is termed, but is received into a pouch called the *crop*, where it is softened and rendered fit for digestion. These birds are in the habit of swallowing pebbles and gravel, which appear to be useful in the *crop*, and to assist in bruising the hard skin of the grain.

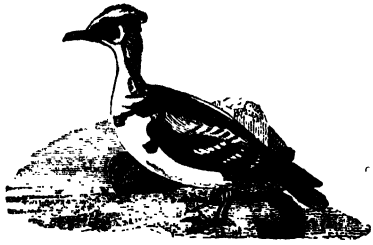
The greatest number of birds live in trees, some on the water, and but very few on the ground only. Those that live in trees and spend their time on land, have the toes separate; as the sparrow, the linnet, and the canary; whilst the goose, the duck, the swan, and other water-

fowl, have their toes connected by a membrane or web, and are hence called *web-footed.* This web enables them to swim readily and quickly, as it offers a wide surface to the water, and serves as a broad oar.

The feathers of birds are of very curious construction. To assist in keeping the body dry, birds are also provided with a gland or little bag, seated near the tail, from which they procure a supply of oil to smear over their feathers, and thus cause the water to run off without penetrating.

QUESTIONS.

What is particular in the structure of birds?
In what way are their feathers arranged?
In what part is a bird provided with powerful muscles?
What are the uses of these?
What is peculiar about the lungs of birds?
Do they differ in this respect from the mammalia?
Do some birds swallow their food whole?
Does it then pass at once into the stomach or gizzard?
What is the name of the pouch into which it is received?
What difference is there in the toes of land and water-birds?
How are birds protected from wet and cold?



LESSON XVI. *Food of Birds; Granivorous and Carnivorous Birds; the Condor.*

THE food of birds is various. Some live principally on worms, caterpillars, and insects; others, as birds of prey, eat mice and other animals; others live on seeds and grain. Birds of prey are called *carnivorous,* or flesh-eating, and those which live on seeds *granivorous,* or seed-eating.

Granivorous birds are the most prolific and most useful to man, as they are easily tamed and domesticated. They are in general social, or gregarious, in their habits, and often live together in great numbers, as rooks and doves. The fowl, the duck, the goose, and the turkey, are used very largely for food, their flesh being sweet and good, and highly nutritious. The goldfinch, the chaffinch, and the linnet, which delight us with their song, are granivorous, and may be seen busily pecking the thistle and groundsell when ripe; whilst the yellow-hammer, the bunting, and the reed-sparrow, run along the ground, collecting the seeds of the different kinds of grass.

Carnivorous birds have very different habits from the granivorous. Their manners and dispositions are, in general, fierce and unsocial towards each other, and they are rarely seen in

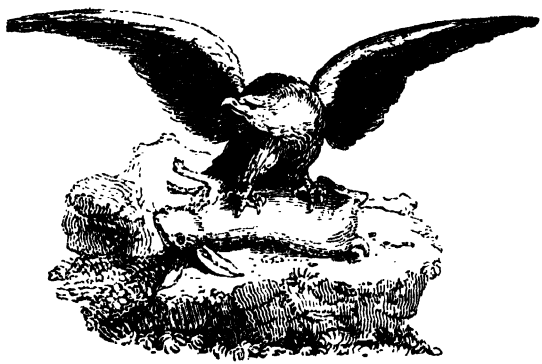
flocks or companies. Each pair build themselves a separate habitation, either on the top of some lonely rock, or in the depths of thick woods, and suffer nothing else to dwell near them. Many, as the eagle and the hawk, have strong and active bodies, a powerful sweep of wing, and are armed with curved bills and strong talons. Their heads are commonly large, with a short neck; and they possess very acute senses of sight and smell. The hawk may be observed soaring at so great a height that it appears only a speck, when, all at once, it will descend like an arrow, and pounce upon its prey, perhaps a poor wren cowering amongst the grass, and hardly visible. The vulture, also, will scent a piece of carrion at an amazing distance.

The condor, which is the largest flying bird, is carnivorous. It is a very powerful creature, sometimes standing a yard high, and its wings measuring six or eight feet from the tip of the one to that of the other. It lives in the most elevated situations, and where no other animal or vegetable can exist, making its home on the very highest ridges of the Andes mountains, in South America. From these vast heights it soars still higher, and then looks down on the plains, three or four miles beneath it, for prey. It lives partly upon carrion, and likewise destroys deer, vicunas,

and other animals; but it has been seldom known to attack man. This immense bird builds no nest, but places its eggs on the bare rock. During the time it is rearing its young ones, it commits terrible ravages among the cattle and herds of wild horses, with which the extensive plains of its native country abound.

QUESTIONS.

On what do birds live?
What name is given to those which feed on flesh?
Why are granivorous birds the most useful?
What are their habits?
Name some of these birds.
In what respect do carnivorous birds differ from granivorous?
Have they quick senses?
Give an example.
Which is the largest flying bird?
In what situation does the condor dwell?



Lesson XVII. *Plumage of Birds. The Voice of Birds. Song Birds.*

The plumage of birds is, in many instances, of the most beautiful kind. Nothing, indeed, can exceed the splendour and brilliance of the different colours with which the Father of all things has clad the "winged denizens of the air," as birds are sometimes called. The skins of the birds of paradise, which are brought to England, are of dazzling lustre. Some of them have tippets of feathers, spreading over the breast and back, of the richest hues; and others have long lines of feathers, of the most delicate structure, springing from beneath their wings, or branching from the head in the most curious and beautiful manner. So richly are these creatures clothed, that although their bodies are not larger than that of the blackbird, yet from their quantity of plumage they appear as large as the pigeon; and it is impossible for them to fly, except against the wind. The dress of the humming-birds is equally splendid, and when they are seen flittering about amidst the brilliant flowers of a South American forest, they are dazzling to the eye. Some of our own birds are also very richly drest. The feathers on the neck of the common cock,

when he is in complete plumage, possess a metallic lustre hardly to be matched; and the "eyes" in the tail feathers of the peacock are as splendidly bright as the golden breast of the green humming-bird.

Birds shed their feathers at certain periods of the year, and have thus annually a new dress, to preserve them from cold. This process is termed *moulting*, and birds generally are weak and languid whilst it is going on. The largest feathers are in the wings, and from these, quills are made. Some birds have no pinions, or quill-feathers, and on this account cannot fly, as these are requisite to enable them to support themselves in the air. The ostrich, as we have already observed, the cassowary, the penguin, and some others, are in this condition.

Every species of bird has its own peculiar voice. Some birds easily imitate the song of others; and if a number of young birds are shut up with a full-grown one, they all acquire the same general tone of singing. An American warbler, called the mocking-bird, in a state of nature, imitates the cries and notes of its neighbours with the greatest clearness; the bullfinch and canary may be taught to pipe a variety of tunes correctly, and one of the latter has even been taught to speak a few words. This talent

is more common in the parrot kind, which soon learn to articulate words, and will repeat a sentence, or sing a song accurately both as to words and tune. A parrot has been known to sing upwards of fifty different songs, keeping time with its foot, and never missing a word. This famous bird, when moulting and unwilling to sing, turned its back to all who asked it, and repeatedly said, "Poll's sick."

Song-birds are a delightful race of creatures. During the spring and early summer, and occasionally in autumn, the whole air is filled with the sound of their gladness; not a bush, brake, shrub, hedge-row, or tree, but has its little chorister, each striving with the other in a rivalry of voices. The linnet, the thrush, the blackbird, the goldfinch, the wren, and many others, are either residents with us, or periodical visitors; whilst the "household-bird," the robin red-breast, throughout the winter warbles its cheerful melody close to our habitations.

QUESTIONS.

What birds have the most beautiful plumage?
Which of our birds is very richly dressed?
What is meant by the term moulting?
What birds are without pinions, or wing-feathers?
Can these birds fly?
Can birds imitate the voice or song of each other?
What bird does this particularly?
What birds are easily taught to pipe, and repeat words?
Mention an example of this.
Can you name a few of our chief song-birds?

LESSON XVIII. *Birds' Nests. Sitting of Birds. Age of Birds.*

BIRDS' nests strikingly show the care taken by God of all His creatures. The instinct which leads to their construction affords some of the most curious proofs of animal sagacity. The beauty of their contrivance, the selection of materials, their firmness of structure, all render these "leafy homes" objects of admiration; and

the more so, if we consider the means possessed by the little architects, and the nature of the substances on which they have to work.

Every species of bird is directed by Providence in selecting the fittest materials for its nest; it likewise builds the nest in situations where its wants are most readily supplied, and where it can best defend itself. Some birds, as the finches, use light and simple materials, such as hay, roots, leaves, and reeds; and others, as the thrush, in addition to these, prepare a sort of mortar, from clay and wool, and plaster their nests. The Cape-titmouse makes a snug dwelling of vegetable down, which looks like flannel, and constructs at its side another little nest for the male. In most cases the female is the builder, though often assisted by the male in the collection of materials, except amongst the swallows, where both work with equal industry. The male bird generally gathers food for his mate, and cheers her labours by his song.

The shape of nests differs very widely, and is much more simple in some species than in others. The snipe, the bustard, and the plover, content themselves with a plain bed of twigs and straw placed on the ground, and sheltered from wet. The jay, the sparrow, and the jackdaw build warm and comfortable nests in clefts of rocks,

in hollow trees, and in old walls. A number of singing-birds, as the wren, build in the shape of a cup; others, as the hedge-sparrow, in the shape of an oven; and others, in that of a purse, which they hang between the branches of trees. The engraving prefixed to this lesson shows the male and female humming-bird and their nest.

Birds are very careful, in finishing their nests, to guard the opening from wet, and to make the outside as near the colour as possible of the branch which supports them. The nest of the long-tailed tit is shaped like an egg, and has only a very small opening at the top; over this the bird fixes a feather in a slanting direction, so as to carry off the rain; and if the finger is passed into the mouth of the nest, several feathers are found placed crosswise, as an additional protection.

When the nests of birds are undisturbed, and they have laid the usual number of eggs, which varies in different species, the female begins to sit. The constancy with which this sitting, or incubation, is continued, is a beautiful illustration of the instinct of animals. If the mother-bird were to absent herself for a few hours, and leave her eggs exposed to the cold, the young ones contained in them would be destroyed. This fact she has been taught by God; and, contrary

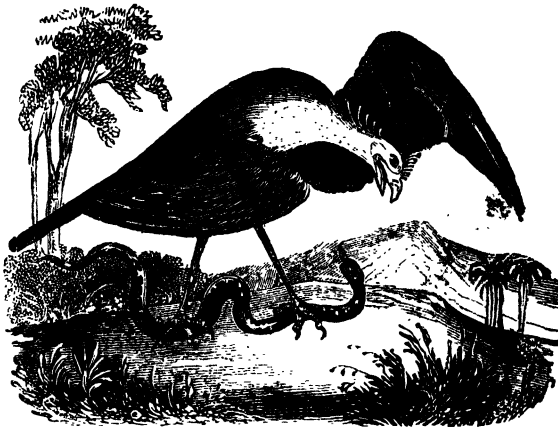
to all her usual habits, she remains day after day, very rarely stirring; and in some instances she sits so closely, that she does not even venture to go out in quest of food, and would perish on the nest if she were not fed by her mate. We have, indeed, known examples in which the white-throated wren, though a very shy and timid bird, has suffered herself to be taken by the hand, rather than abandon her eggs. The length of time required for hatching differs in different species. The common fowl hatches in about twenty-one days.

The position of birds during sleep is various. Some, like poultry, roost standing on a small perch, which they grasp with their toes; while storks support themselves standing on one leg.

Some birds live to a great age. The eagle and the parrot will live, it is said, under favourable circumstances, a hundred years; and geese, finches, and doves have been known to be twenty years of age.

QUESTIONS.

In what situations do birds build their nests?
Mention their materials.
Which bird is the builder?
How does the male bird employ himself whilst his mate is building?
By what means is the nest of the tit preserved from wet?
What affords a beautiful example of animal instinct?
What would be the consequence if the mother left her eggs exposed?
By whom has she been taught this?
How do birds rest during sleep?
To what age do some birds live?



Lesson XIX. *Services rendered by Birds to Man. Mischief done by Birds.*

Birds render many important *services* to man. The vulture, though disgusting in its habits and appearance, is exceedingly useful in hot countries. It is called the *scavenger*, as it clears the streets of towns from offal, and dead matter of all kinds, which decays rapidly, and which would make the air unwholesome and disagreeable. The crow, the kite, the hawk, and the raven, destroy field-mice, and other small animals, which, if permitted to multiply without check, would do great injury to the crops of the farmer.

Insects and vermin are removed in vast numbers by birds, and although the sparrow and the rook are often considered as troublesome and expensive visitors, and boys are employed to scare them off our fields, yet if they were entirely to be got rid of, the land would be overrun, and our crops injured or destroyed, by swarms of minute creatures, which these birds prevent from increasing too fast. The stork and the crane destroy frogs, lizards, and snakes. One of these birds so employed, is shown in the engraving; ducks clear the gardens and fields of slugs; and the titmouse and swallow devour myriads of caterpillars, insects, and grubs.

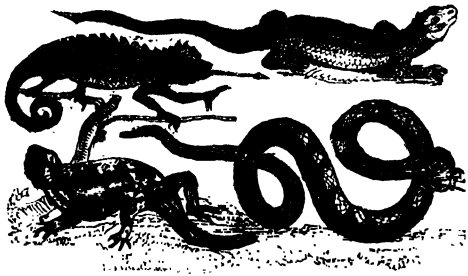
Many birds destroy weeds, and others promote the extension of useful animals and vegetables in a wonderful manner. Trees, that are often found growing upon high walls, or rocks, have in general been planted there by birds, which have swallowed the seed, and deposited it on places out of common reach. Wild geese, in their journeys, convey fish-spawn to distant ponds and lakes; and sea-fowl, which gather in thousands, deposit their dung on bare rocks and cliffs on the sea-coast, from which, in the course of time, a soil is formed, and thus they become covered with vegetation.

The *mischief* done by birds is very trifling

when compared with the services which they render us. Birds of prey, as the condor, the great eagle, and the vulture of the Alps, now and then kill colts, calves, goats, and sheep. The hawk picks up occasionally a stray chicken, or pigeon; as also do the falcon, the sparrow-hawk, and the butcher-bird. The heron, the osprey, and other water-fowl, are destructive to fish, and fish-spawn. Storks, which are supposed by superstitious people to bring prosperity with them, and are carefully protected in some countries, though highly useful, are also mischievous birds; they not only devour frogs, field-mice, and moles, but also chickens, larks, fishes, and fish-spawn. Sparrows, and many singing-birds, do injury to ripe corn and fruit; but, in many instances, they amply compensate for this by pecking insects and grubs from the young buds.

QUESTIONS.

Why has the vulture been called the scavenger?
What useful service is performed by crows, kites, and hawks?
What would be the consequence if rooks and sparrows were destroyed?
What birds clear away frogs, lizards, snakes, and slugs?
What birds devour so many caterpillars and insects?
In what manner are trees sometimes planted?
By what means are distant lakes and rivers stored with fish?
What mischief is done by birds?
Mention one or two instances.
How do sparrows and other birds compensate for the injury they do to corn and fruit?



LESSON XX. *Reptiles. Structure of Reptiles; Clothing of Reptiles; Poisonous Animals.*

REPTILES form the third class of the Vertebrata. The word Reptile signifies in general anything which creeps, but it is used in a more strict sense by naturalists. Frogs, lizards, crocodiles, alligators, tortoises, turtles, and serpents, are reptiles.

Reptiles differ very widely from both the mammalia and the birds in structure, habits, and appearance. The latter have red, or warm blood, and are of the same heat as ourselves, and are hence called warm-blooded animals; but in reptiles the blood is of a paler colour, and they generally feel cold to the touch, and have, in consequence, been called cold-blooded animals.

They breathe, however, by means of lungs, which are transparent, and of very fine texture; but they are capable of living a long time without drawing breath. Creatures of this class can also endure extreme degrees of cold without perishing. Instances have been known in which frogs embedded in thick masses of ice have been found living, when the ice has thawed gradually and slowly.

Some of the reptiles are found only on land, and others are inhabitants of the waters, but the class also contains a great number of Amphibia, or such animals as occasionally frequent both, as the crocodiles.

Most reptiles have voice; the frog, for example, croaks, and the serpent makes a hissing noise. The organs of voice are, however, in general, much weaker than in the former classes, and some of them, as the green lizard, are quite mute.

The shape of reptiles is very various. Crocodiles, tortoises, frogs, lizards, and newts, are four-footed. Serpents, on the contrary, are without feet, or any external organs of motion. These have, nevertheless, the power of moving in a zig-zag line with great rapidity, by contracting their under scales, which may be compared to feet; and when irritated or alarmed, they raise themselves on their tails, and dart

forward with great force to a considerable distance.

God has clothed many of the reptiles in a wonderful manner. Some are cased in bony coverings so hard and so strong, that scarcely any weight is sufficient to crush, or any blow to injure them; and into these cases, on the approach of danger, the animals withdraw their bodies. The tortoise is a remarkable specimen of this class, as it will bear immense weights without injury. Others are defended by numerous horny rings, strong scales, or shields; and others that have naked bodies, are covered with thick and glutinous slime. Many of them change their skins from time to time. Some are remarkable for the sudden alterations of colour they undergo. Several kinds of lizards have this peculiarity, more especially the chameleon. Many of the serpents have their bodies beautifully marked with the most lively and brilliant colours, and when slowly waving along the ground, produce very striking effects on the eye. Several lizards are also equally beautiful in colour.

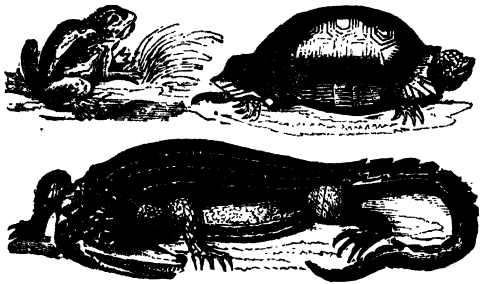
Some poisonous animals are found in the class of Reptiles. The viper, the rattlesnake, the hooded snake, the asp, the whip-snake, and others, inflict deadly injuries by their bites, as they convey into the wounds made by their

teeth a poison fatal to life. The *poison-fang* of serpents is one of the most singular contrivances in the whole animal world; but fortunately these creatures are in general inoffensive and timid, and seldom use their deadly weapon against man, unless made angry or injured. The viper or adder is the only venemous reptile found in England, as the common snake is entirely harmless.

In the engraving prefixed to this lesson are represented four specimens of reptiles. These are the chameleon, two lizards, and a serpent. The chameleon is seen darting forth his tongue, which he covers with glutinous slime; it admits of being projected to the length of six inches, and it is used in this manner by the animal in catching its food, which consists of flies and other small insects.

QUESTIONS.

What creatures form the third class in the animal kingdom?
What difference is felt in touching reptiles and mammalia?
How does this arise? and what name is given to reptiles in consequence?
Have they lungs? and what is remarkable about their breathing?
Where are reptiles found?
Have all of them voice?
What reptiles are four-footed?
By what means do serpents move?
Mention how some reptiles are clothed.
What is remarkable in the colour of these animals?
In what class are poisonous animals found?
How is this poison applied?
What venemous reptile is found in England?
Can you describe the manner in which the chameleon catches its food?



LESSON XXI. *Habits of Reptiles; Tortoises; Food and Vitality of Reptiles.*

THE young of reptiles are produced from eggs; they are, therefore, *oviparous*, like birds; but they differ widely from birds in one respect, namely, that the eggs are not hatched by the mother, but by the warmth of the sun, after she has deposited them in proper places for this purpose. These places, however, she selects with the utmost care and foresight, so that the eggs may be safe, and that the young ones, when they come out, may find a supply of food.

The great number of reptiles pass the winter months in a state of torpidity. Some of them, as frogs and lizards, are occasionally found in this state, in considerable numbers, at the bottom

of ponds, or under heaps of rubbish, or the foundation of old walls.

Tortoises and turtles, which both belong to the same family, live partly in rivers, partly in the sea, and partly on the land. At certain seasons, when they lay their eggs, they travel great distances to reach suitable situations. The wide current of the river Orinoco, in South America, is at such times covered for miles with these creatures; and in some of the West India Islands, where the smaller tortoises chiefly gather together, the ground is covered with them for great distances as they travel to the sea-shore, for the purpose of laying their eggs in the sand. They lay more than a hundred eggs at short intervals, digging shallow pits, and then covering them with a layer of sand. The mother takes no further care of them, and they are hatched by the heat of the sun. The moment the young ones escape from the shell, they hasten to the water, instinctively taught by their Great Preserver, that this is their proper home during the first weeks of their existence, and the only mode of escaping the numerous enemies which are lying in wait for them.

Some kinds of turtle, as the green and the loggerhead, grow to a vast size, weighing as much as eight hundred or one thousand pounds.

The green turtle furnishes excellent food, which is largely used in the West Indies, and they are brought to Europe in great numbers as a delicacy. Tortoises and turtles have strong bony coverings or shells, which afford a protection against all their enemies, except man. The upper part of these shells is composed of large horny plates, which are in some species beautifully coloured. This, when separated from the rest, is known under the name of tortoise-shell, and is used for a variety of useful and ornamental purposes, as the making of combs, boxes, and spectacle-cases.

The food of reptiles is very various. Serpents live on small animals; tortoises on sea-weed, called turtle-grass; lizards and toads on insects and worms. Nearly all reptiles are capable of living for considerable periods without food. The salamander will fast for several months, and the tortoise for upwards of a year; and neither of them appear to lose much bulk by their want of food. The tenacity with which these cold-blooded animals cling to life is also very remarkable; they often recover from dreadful injuries, and sometimes, even when a part of their body has been destroyed, as a leg or a tail, it is reproduced in the course of a few months.

The figures in the engraving represent a frog, a tortoise, and an alligator.

QUESTIONS.

How are the young of reptiles produced?
What places does the mother select for depositing her eggs?
In what situations do turtles live?
What is remarkable in these animals when about to lay their eggs?
Where are they sometimes seen in vast numbers?
How many eggs do turtles lay?
and what kind of nests are they placed in?
What is singular about the young of turtle?
How are tortoises protected?
What is tortoise-shell, and for what is it used?
What is singular among reptiles with respect to eating?
Are they very tenacious of life?

LESSON XXII. *Age of Reptiles. The Crocodile; Boa; Toad; Surinam Toad.*

MANY reptiles grow slowly and are very long-lived; indeed, a general remark may be made here which the reader must bear in mind; throughout the animal and vegetable kingdom, whenever an object grows to a great size, or grows very slowly, it invariably grows to a great age. Thus, the whale, which attains so vast a magnitude, is supposed to live some hundred of years; and the oak, the king of our forests, which increases in bulk very slowly, will live for a thousand years, and witness many generations of quick-growing trees perish around it whilst it is yet in its prime. Tortoises have been known upwards of one hundred and twenty years old

and it is probable that the crocodile and the larger snakes live to a very great age in their native haunts.

The largest animal living in fresh water is the crocodile, one of the reptiles. It is a native of the large rivers of India, Egypt, and other hot countries, and in some situations is found in great numbers. It sometimes grows to the length of thirty feet, and is possessed of such great strength, that it can carry off with ease a man, a tiger, or an ox. The upper part of the body is covered with hard scales, which serve as armour, for they have been known to turn a bullet. The crocodile resorts chiefly to swampy grounds covered with weeds, and inland lakes, but never approaches the salt water. When waiting for prey, it generally lies motionless on the water, like a log of decayed wood, near places where animals come to drink, upon which it seizes and drags to the bottom. The female lays about a hundred eggs, and is so prolific, that were it not that snakes of all kinds are fond of crocodiles' eggs, and destroy vast numbers, the countries they inhabit would be overrun by them. In Egypt, a little animal, called the ichneumon, has a wonderful instinct for finding the eggs of crocodiles, and destroying great numbers of them. Though these creatures are

of such immense bulk, their eggs are but the size of those of the goose, and are covered by a thick leather-like skin. Alligators, which abound in South America, are very similar in habits and appearance to crocodiles, and belong to the same family.

The boa-constrictor, another of the reptiles, found in the East Indies, attains a great length. It is the largest of the serpents, and kills its prey by folding itself round and round its victim with the utmost quickness, and then crushing it to pieces. Its muscles are exceedingly powerful, and capable of pressing even a bullock or a tiger to death.

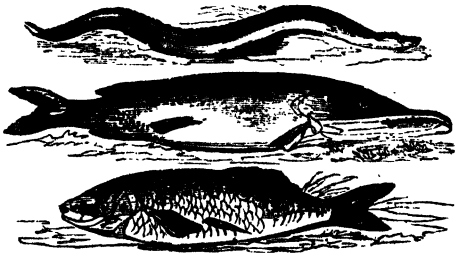
The common toad is popularly looked upon as venomous. This is an error, as it is, in fact, a harmless and timid creature, and very useful in gardens. It feeds chiefly upon insects, which it catches with the most singular dexterity. Crouched behind a cabbage-leaf, it watches attentively till a fly settles within its reach, when in an instant it darts out its long tongue, and very seldom fails to strike it. This is done so quickly that the eye can hardly perceive the motion. To secure the insect, its tongue is covered with a thick sticky saliva, which holds it, as if it were bird-lime. The eye of the toad is particularly bright and beautiful, so much so,

indeed, that it has been said to "wear a jewel" in its head.

The Surinam toad, which is found in South America, rears its young in a very singular way, and quite different from the rest of the species. Toads generally lay their eggs in large masses, which are found floating on the surface of stagnant water; but the Surinam toad has a number of little cells on her back, and when she has laid her eggs, the male takes them up and spreads them throughout these cells, in which they remain till they become tadpoles. She thus carries about with her a whole family of little ones, and, instinctively taught, she remains in the water so long as they are incomplete. When the young toads are hatched they are called tadpoles; they breathe by means of gills, and in their habits resemble fish; but in a short time they cast a kind of skin, appear as perfect reptiles, and retire to the land.

QUESTIONS.

What general remark is applicable to the growth and size of animals?
How long have tortoises been known to live?
Where are crocodiles chiefly found?
To what size do they grow?
Are they ever found in salt water?
How do they catch their prey?
How many eggs, and of what size, does the female lay?
What little animal is very destructive to their eggs?
In what way does the boa destroy animals?
Describe the manner in which toads catch insects.
What is remarkable about the Surinam toad?
What are tadpoles?



LESSON XXIII. *Fishes in general. Gills; Form and Colours; Habits and Character; Eyes; Ears; Migrations.*

THE last class of the Vertebrata comprises the Fishes. These dwell only in the water, and differ from the three preceding classes in their mode of breathing. Fish have no lungs, but in their stead have on either side of the neck a very curious and delicately fringed organ, called the *gills*. By means of these, fish breathe: that is, a constant stream of water is passed over them, the air contained in which operates upon them much in the same way as it does when taken into our lungs.

The form of fish is in general very pleasing, and their colours are in many instances strikingly beautiful, the skin being either glossy, or covered

with brilliant scales, sometimes golden, sometimes silvery, and in others of the finest tints of blue and green.

Fish are generally social in their habits, and may be seen glancing in the sun in large shoals; they are also very sportive and playful, are full of activity and animation, and seem happy creatures. Their character in a general way is that of gentleness and harmlessness, and they show no marks of cruelty towards one another, beyond satisfying the common instinct for taking food. There are, indeed, in the sea, as on the land, some fierce and voracious creatures, which are objects of terror; but those which are most abundant, and which come more immediately under our notice, are gentle and beautiful creatures, in no way to be feared, but very much to be admired.

The eyes of fish differ from our own in their shape and structure: as they live in a different element, the care and wisdom of their Creator has been shown in the way their different organs are adapted to it. Had their eyes been constructed like those of the mammalia, they would not have been able to see accurately, and would therefore have been unable to catch their prey. This has been provided for, and fish see as well in the water as other animals do in the air.

Fish have no voice, and no external organs of hearing; yet a few, as the tunny and the ling, utter slight sounds; a species of gurnard has a note like a cuckoo; and some fish obviously hear, as carps in fish-ponds have been trained to assemble at the sound of a bell.

Fish are produced from eggs, and in amazing numbers; the roe of a single fish often containing many hundred thousand eggs, or *spawn* as they are termed. Many kinds migrate as the period for spawning approaches, to great distances, often crossing wide seas, in order to reach fit places for this process. The eggs are laid in the sand or gravel, and hatched by the warmth of the sun. The young fish, or *fry*, are capable of supporting themselves the moment they leave the egg, and, governed by a wonderful instinct, they have immediately the same habits, seek the same haunts, and take the same means to defend themselves as full-grown fish.

Fish live to a great age, and many of them attain to a considerable size.

QUESTIONS.

What creatures form the fourth class in the animal kingdom?
In what respect do they differ from the first three classes?
What organs have fish in the place of lungs?
Are the forms and colours of fish pleasing?
Are they social in their habits?
Have fish eyes like our own?
Have they voice?
In what way are the young of fish produced?
How are the eggs, or spawn hatched?
What is singular about the fry, or young fish?
Are fish long-lived?

Lesson XXIV. *Fins of Fish; Air-bladder; Electric Fish.*

The provision made to enable fish to move in the water is very beautiful: this consists of parts called *fins;* and these serve the same purposes as the wings of birds, and the legs and arms of the mammalia. The situation of these fins upon the body, and their number, vary according to the habits and species; the common trout having eight, two on the back, two on the breast, two on the belly, and two single ones; whilst the common eel has no fins on the belly. In the haddock, the fins, which in the trout are placed on the belly, are fixed on the throat; and in the perch, the same fins are fixed close to the pectoral or breast fins. The fins differ greatly in size; they are made up of bony spines, joined together by a membrane, and are moved by strong muscles, just in the same way as the wings of birds, and our arms. By means of these fins, the fish, which may be said to be suspended in the water, can move in all directions easily and with great velocity. Many fish which feed partly on insects, can leap to a considerable height out of the water, in pursuit of them. This is done by means of the tail, which is reckoned as a fin, and is also used as a rudder

by fish to direct their motions. In many instances this is a very powerful instrument; and, in the larger kinds of fish, can inflict severe and even fatal blows.

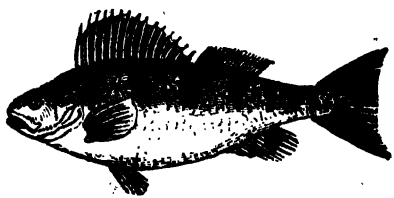
Another very curious organ, with which many fish are furnished, is the air-bladder: this is double, and being placed within their bodies, gives them the power of ascending or descending in the water without any apparent effort, as may be seen by watching gold-fish in a glass vase. This organ renders the body exceedingly buoyant, and is, therefore, called the swimming-bladder. The fish that are unprovided with this organ are generally found at the bottom of deep ponds, lakes, and seas, as the different kinds of flat fish. It is supposed that the fish has the power of secreting or forming air to fill this bladder, and we know of no other animal which possesses anything of the kind.

Several fish are provided, as a means of defence, with a species of electric or galvanic battery, which acts just like a shock from an electrical machine. This is a very extraordinary provision, and is possessed in great perfection by the torpedo, and the gymnote, or electric eel. This last creature abounds in the rivers and ponds of some parts of South America, and grows to a large size; its length being usually five feet.

So powerful is the shock it is capable of giving, as to prove almost fatal, both to man and animals. Mules and oxen, when about to cross a stream infested by electrical eels, take the greatest precaution to avoid being entangled in their folds, and exhibit every mark of terror when attacked by them. These eels fold themselves round the legs and bodies of the animals, and, by a series of electric discharges, so benumb and torture them that they fall down in the water and are drowned. Great numbers of mules are thus lost annually, in some situations.

QUESTIONS.

By what means do fish move in the water?
Are these fins alike in number and situation in all fish?
How many fins has the trout?
In what respect do the fins of the haddock and perch differ from those of the trout?
How are fish enabled to leap out of the water?
Of what service is the air-bladder?
How is it filled with air?
Have other animals anything of this kind?
What singular provision have some fish for their defence?
In what way does this act upon the body?
What fish possess this singular means?
Where is the gymnote found?
How does the gymnote destroy mules and oxen?



THE PERCH.

LESSON XXV. *Herrings; Salmon; the Remora.*

THE providence of God has stored the waters with proofs of his bountiful goodness, and of his great love to man. By his command the waters bring forth abundantly what is of greatest utility to us. There is one single species of fish that annually feeds many thousand people. This is the herring, which appears as abundant as ever, although millions are destroyed every year for our use. Our Almighty Benefactor has so ordained, that this species of fish should increase and multiply so rapidly as to defy all ravages. Season after season it issues from the Polar Seas in vast shoals, which are so broad and so deep, that, for the time, they alter the very appearance of the ocean.

These shoals are divided into columns five or six miles in length, and three or four in breadth, which drive the water before them in a continual ripple. In fine weather these floating millions glisten in the sun, and reflect a variety of splendid colours. Each column is preceded by a herring larger in size than the rest, which seems to govern their motions, and to act as leader.

Herrings, in their annual migrations, appear off the Shetland Islands in April and May; one

great shoal then takes the eastern, and another the western side of Great Britain. The chief fishing-station is near Shetland; but they are caught in great abundance all along the English and Irish coasts. Herrings are important articles of commerce; nearly four hundred thousand barrels being cured annually in Britain, of which a considerable portion is sent to other countries, in exchange for their commodities. Herrings are wholesome and nutritious food, whether eaten fresh, pickled, or smoked.

The salmon is another fish of the utmost value as an article of commerce, and of food, being by far the most delicate fish taken in our rivers. It grows to a considerable size, sometimes weighing fifty or sixty pounds. About the beginning of September, this fish, led by a singular instinct, begins to ascend our streams from the sea, and makes its way as far up as there is water to cover it, often leaping over weirs and ledges of rock, several feet in height, and overcoming all obstacles in the most extraordinary manner. When it has reached a shallow part of the river, the male and female form a trench in the gravel, hollowing it out with their snouts and shoulders to the length of eight or nine feet, and in this the female deposits her eggs, many thousand in number. After

this is done, which occupies several days, both the fish employ themselves diligently in covering up the eggs, that they may be protected from other fish, and from water-fowl, which greedily devour them. The eggs are then left by the parents; in March, the fry, or young fish, are formed, and appear in vast numbers, keeping near the shores, and gradually descending the rivers, till the first floods in May carry them out into the sea.

The remora, or sucking-fish, is another singular instance of the care taken by God of his creatures. This fish lives in the sea, and having very small fins, is incapable of quick motion. To compensate it, however, for this weakness, it has, on the crown of its head, a curious apparatus, by which it can fix itself firmly to any larger body, as another fish, or a ship, and thus be carried along with it.

QUESTIONS.

From what seas do herrings issue every year?
In what manner do they make their appearance?
What are the length and breadth of the columns of herrings, and how are they led?
In what month do they reach Great Britain?
Near what islands is the principal fishing station?
How many barrels of herrings are cured annually in Great Britain?
At what period of the year do salmon ascend our rivers?
For what purpose do they thus ascend the rivers?
Is any care taken by the fish in depositing their eggs or spawn?
At what time do the young fish appear?
What is remarkable about the remora?

LESSON XXVI. *Insects in general. Breathing; Eyes; Feelers.*

THE power and wisdom of the Supreme Being are made manifest in a wonderful manner by the *Insect world.* We cannot ramble on a summer evening, but we find the air filled with sportive and happy creatures. Every leaf, every branch, every pool, every bank, abounds with animal life; and every insect, however minute, is seen pursuing, with unerring regularity, its settled course of action, and fulfilling some important purpose for which it has been created. Some are busy supplying their wants, others in providing for their offspring, others, again, are exerting wise precautions to screen themselves or their eggs from danger, and others are laying up stores of provisions. Their endless variety of form, their infinite number, and the care which has been bestowed upon them, fill us with astonishment and joy in beholding them; and strange must be the disposition of heart in any one who is not led, from the contemplation of such creatures, to adoration of the Creator.

Insects, under which name is commonly included flies, beetles, butterflies, and many similar creatures, form the fifth class into which all living beings were divided by Linnæus, but more modern

naturalists have formed many new classes, and have separated from the Insects, the Spiders, which they arrange under a class called Arachnida.

The insects differ materially from the four classes already described, in their structure, their forms, their habits, and their appearance. They have been called *articulated* animals, from being made up of many jointed parts, without having a regular system of bones. Mammalia, birds, reptiles, and fishes, breathe either by means of lungs or gills. Insects have neither, but are furnished in their places with a number of little breathing-holes, called *spiracles*, disposed along their bodies, through which the air passes; as all animals have some organs of respiration, these being essential to animal life.

The formation of the eyes of insects is very curious. Those of other animals are single, and seldom exceed two; but in this class, what appears to be a single eye, is, in fact, a collection of eyes, being made up of a number of distinct lenses, looking in all directions. These creatures have, therefore, no need to turn their heads in any way, in order to see either upwards or downwards, to the right or to the left. The two large eyes of the dragon-fly, which is so common with us, have been found to contain above twenty thousand of these little eyes or

lenses. Spiders have eight eyes, two on the top of the head, two forward, two backwards, and two in front, so that they can look nearly all round them at the same moment; they are thus enabled to secure the fly for food, on whatever side it may happen to be.

Insects are provided with very singular organs of feeling. These are called *antennæ*, and are fixed on the head, like long delicate horns. They are hollow, jointed, and moveable, and in some instances of great length and beauty. They are very sensitive, and with them, these creatures feel their way, as the bodies of many of them are covered with hard and insensible coats, as hairs, scales, or horny membranes. In addition to the antennæ, insects have other feelers ranged round the mouth; these serve them to catch their prey, and as hands to hold it, whilst they are engaged in eating.

QUESTIONS.

What is made strikingly manifest by the insect world?

Of what does the fifth class in the animal kingdom consist?

What name has been given to insects from their jointed structure?

In what respects do insects breathe differently from mammalia?

How do the eyes of insects differ from those of other creatures?

What advantages do insects derive from this?

How many eyes has the spider?

What are *antennæ*, and what are they like?

What is their use?

Have insects other feelers besides *antennæ*?

Lesson XXVII. *Trunk or Tongue of Insects; Wings; Feet.*

The tongue of insects is a highly curious instrument, and should be rather termed a proboscis or trunk. A good idea may be had of its uses and form, by looking at that of the huge elephant. Many insects live chiefly on honey and other liquids, and in these instances the proboscis serves as a syringe or sucking pump. The proboscis of the butterfly is very long, and curled up like a spiral wire. This the creature can unfold at pleasure, and insert into flowers, at the bottom of which the honey lies. The bee may be observed, ranging from flower to flower, busily thrusting its tongue into them, and loading itself with sweets. The common fly has a proboscis shaped like a club, through which it will speedily imbibe a drop of milk, or a few grains of sugar. It is curious to watch how cleverly it uses this organ, and how busy it generally is with it. Other insects, as the gad-fly and the gnat, feed chiefly upon the blood or juices of larger animals. In these the tongue serves as a borer to pierce the skin, which has first to be penetrated, before they can reach their food. When this is done, the tongue becomes a sucker, and draws the liquids into their stomachs.

Many insects are provided with wings of the most beautiful texture and appearance. Those of the dragon-fly and the house-fly are of fine yet strong texture. Some of the beetles have wings of surprising delicacy, which are folded in a wonderful manner under strong cases, when they are at rest. The finest gauze that can possibly be made is coarse in comparison with these fine and transparent membranes, or wings; and no hand but the hand of God could make fabrics of such beautiful texture. Yet, fine as the wings are, a microscope shows them to be covered with minute scales of the most brilliant colours, which resemble small feathers. Many butterflies are singularly elegant creatures, and have been well called "flying flowers." One of our poets, in speaking of the yellow spring butterfly, has very aptly and beautifully called it—

> . . . . The butterfly
> That o'er the primrose restlessly,
> Itself a flying primrose, hovers.

The wings of insects are moved by muscles like those of birds. It is astonishing how fast they can fly. A swarm of common flies will accompany a horse at full gallop; and naturalists have calculated their flight at from thirty to forty miles an hour.

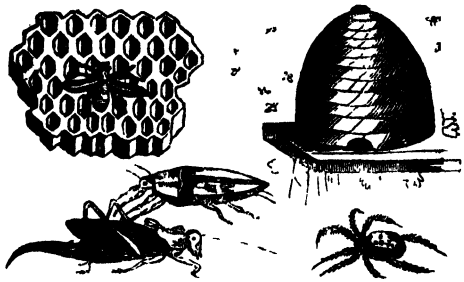
The number of legs possessed by insects is

another of their peculiarities. None of them have less than six, and others have twelve, twenty-four, thirty, forty, fifty, one hundred, and even more. The feet of the house-fly are very curious. This active creature walks steadily along the smoothest surfaces, upwards or downwards, as may be often seen on a pane of glass. To enable the fly to do this, its feet are so formed, that when placed flat, a slight vacuum is produced in the centre, which holds the edges fast, just in the same way that the hand sticks to a wetted slab, when the palm is a little raised, and as boys lift up stones by a piece of moistened leather with a string through it.

The motions of the gossamer spiders are as curious as those of the flies. These little creatures climb to the tops of trees, and then spinning a light web, they are borne aloft on it by the breeze, and rise to very considerable heights in the air, probably in search of their food.

QUESTIONS.

How may we obtain an idea of the trunk or proboscis of insects?
For what is this used by the butterfly and bees?
What shape is the trunk in the common house-fly?
What insects use their trunks both as a borer and a pump?
Are the wings of insects of very beautiful texture?
What insects have particularly delicate wings, and how are these defended?
With what are the wings of butterflies covered?
How are these wings moved?
How many legs are insects provided with?
What enables the fly to walk on smooth surfaces?
How is this done?



LESSON XXVIII. *Habits of Insects. Carpenter Ants; Bees; Wasps.*

MANY insects exert great ingenuity and labour in constructing their habitations. The black *carpenter ant* hollows out cells and passages in the trunks and roots of trees of very hard texture. It eats away the fibres with its nippers, and works with the utmost nicety. When a piece of wood which has been colonized by these little creatures is examined, it presents a most curious appearance, being pierced throughout, and the partitions between the cells are far thinner than paper. What is very singular is, that these excellent carpenters never spoil their work, nor open one cell into another, every one being found perfect and smooth. In these wonderful

houses we find arcades and galleries, leading to the various divisions, all finished with the nicest skill; and though the whole trunk of a tree seems bored in every direction, it is nevertheless left quite strong, and generally lives as if untouched. These colonies are very populous, upwards of a million of ants being found congregated in a very small space.

The habits of bees are very interesting. The instinct displayed by them in a variety of actions, whether in a wild or domesticated state, is a source of continued wonder and admiration. The structure of their cells, the treatment of their eggs, the government of their hives, and their storing of food, are all equally remarkable.

Every full bee-hive contains three different sets of inhabitants: namely, a queen-bee, two thousand drones or male bees, and twenty thousand neuters or workers. There is never more than one queen; if another is formed it is destroyed at once, and its body removed. The drones are regularly killed by the workers in August, when the breeding time is over. This is done in order that the winter stock of food may be preserved, and not eaten by a greater number than are actually useful.

The working-bees perform all the labour of building the cells; they also guard the hive and

the queen, collect and store the honey, make the wax, and feed the young. In constructing their houses, they first gather a kind of cement from the gummy buds of flowers, which they knead into little balls with their proboscis and legs, and carry it away to stop up all the crevices, and make the hive safe from intruders. This done, they next fetch matter for wax, which is made from the fine dust or pollen found in flowers; this the bees first eat, and it is then changed to wax in the stomach. From this wax one set of workers construct cells, having six sides, and of the most beautiful regularity; the shape of these cells is shown in the first figure engraved at page 130, which represents a piece of honey-comb. By giving the cells this shape, the greatest number possible are contained in any given space; an arrangement which long puzzled the wisest men, but which these creatures, taught by their own Divine Author, had practised from the first hour of their creation. These cells are used partly to hold honey, closely covered by lids, and partly as nests in which to place the eggs.

When a number of cells are completed, the queen-bee begins to lay her eggs. During this process, she is attentively fed and followed by the workers, who remove every egg, and place it in a separate cell. During the summer, it has

been calculated that a single queen will produce forty thousand eggs. She first lays the eggs which are to give birth to working-bees, [illegible] drones, and lastly, a few are stored away in cells set apart for this particular purpose, for a supply of queens, lest the present sovereign should be destroyed, or the hive should become so populous, that a part of its inhabitants may have occasion to remove.

The eggs which have been deposited in the cells, in the course of a few days, pass into a grub state, and are carefully fed by the untiring workers, with a peculiar food they prepare for them. This continues for about a week, when the grubs or maggots wrap themselves in a silken web, and are closed up in their cells with a covering of wax. In this state they remain for a fortnight, changing their skins several times; and, finally becoming perfect bees, they eat their way through the lid of their nests, and, in a few hours, they join their fellows, and fly away with them to work.

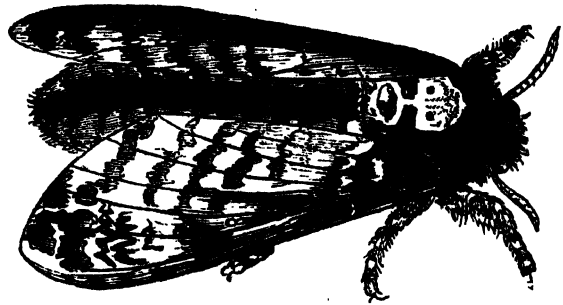
From the rapid increase of numbers in a hive, it often becomes over-tenanted. When this is the case, the bees may be observed to be agitated and uneasy, running in and out, and interrupting work. There is, in fact, a sort of civil war raging within the hive, which ends by a portion

of the bees being driven out. This is called swarming; the expelled bees are always accompanied by one or more queens, which govern the rest, and wherever they settle, the whole number immediately alight around them, in a cluster. The keepers of bees take this opportunity to turn an empty hive over them, and in this they at once settle themselves, and become a new colony. The second figure engraved at page 130 represents a bee-hive.

Wasps construct very curious nests in holes in hedges, in which they deposit their eggs. These nests are divided into cells like a bee-hive, and are formed from a paste prepared from the fibres of plants, which, when dry, resembles brown paper.

QUESTIONS.

In what situation does the carpenter ant make its home?
By what means does this little insect work its way?
Are the habitations of the carpenter ants of very curious contrivance?
What is remarkable in the trees inhabited by them?
How many different kinds of bees are there in one hive?
Is there ever more than one queen?
What becomes of the drones?
What bees perform all the labour in hives?
What is the first step taken by bees in a new hive?
Of what is bees' wax made?
What is the shape of the cells in a honey-comb?
What is very singular as to the shape?
How many eggs does the queen-bee lay?
What becomes of these eggs?
What kind of eggs are first laid?
Describe the changes these eggs undergo.
What happens when hives become too populous?
Describe a wasp's nest.



LESSON XXIX. *Changes of Insects.—Cabbage-butterfly; Gnats; Death's-head Moth.*

ONE of the most striking circumstances in the natural history of insects is the curious and extraordinary changes in shape, or *transformations*, through which they pass. First appears an egg, then a grub or maggot, next a caterpillar, then a chrysalis, and in the end a perfectly formed insect. In these various states the animal often dwells, first on vegetables; next under ground, or in the water: then, on land; and eventually it is clothed with wings, and lives chiefly in the air. These changes often occupy years, for the stag-beetle remains a larva or grub for six, and the day-fly for three, years. The care of Almighty God has, however, amply provided for

them during these changes; and we cannot sufficiently admire His wisdom, who feeds and clothes the maggot hidden under ground, equally with the splendid insect which is to spring from it.

Any one who examines a cabbage-leaf will find little parcels of eggs, and if these are watched, caterpillars will be found to come from them. Each has sixteen short legs, twelve eyes, which are exceedingly small, and a pair of jaws, with which, as it crawls, it is constantly eating. Each creature keeps increasing in size, changes its skin several times, and then seeks out some concealed place, either in walls, or under ground. It then loses its caterpillar form, and becomes a chrysalis or pupa, that is, an egg-shaped case, inclosing a living creature; and now it has neither mouth nor eyes, legs, nor wings: it does not eat, and lies torpid. In this state it continues for several months, and then escaping from its confinement, it comes forth a butterfly, furnished with beautiful wings, and with six legs: it has now no jaws, but a curled trunk or proboscis, for sipping honey, and has two long horns springing from its head, and only two eyes. Can anything make us feel more sensibly the power, the wisdom, and the wonderful ways of our Creator?

Gnats undergo very singular changes. The female gnat lays her eggs on the surface of the

water, and to prevent them sinking covers them with a kind of glue, at the same time fastening them by a thread to the bottom, that they may not be driven away from the place which she knows to be suited for them. As these eggs grow, they keep sinking deeper and deeper, and at last the young gnats leave them in the form of worms, and burrow in the mud, making themselves a coating of cement. After this, they again change their form, before appearing as perfect gnats, and may be seen in stagnant pools hanging with their heads downwards, and their tails on the surface of the water, for, at the latter part they have a sort of funnel for breathing. The head is now covered with little hooks, by which they seize upon minute animalcules and bits of grass, on which they feed. After this change they turn into chrysalides, and are rolled up in a spiral form; now they do not feed at all, but lie on the water, and, on the least disturbance, unrol themselves, and plunge to the bottom by means of small paddles, with which they are provided. From this state they become perfect gnats, and leave the water. The head of the gnat is ornamented with a beautiful tuft of feathers, and its whole body covered with fine hair and scales. All these are very surprising changes, and cannot fail to impress us

with admiration of the care of their Creator for the preservation of such minute animals.

The largest *larvæ*, or caterpillars, found in our gardens, are those of a very rare insect called the death's-head moth. This name is given to the creature on account of having markings on its back, which bear some resemblance to the head of a skeleton. These caterpillars are of the most singular appearance, having horns, and a tail; they are often five inches long, and as thick as a man's finger. The perfect death's-head moth is engraved at page 135.

Moths and butterflies are often confounded together, though they really are very different, both in their appearance and their habits. They may be readily distinguished when they are seen settled on a flower, as the butterflies then hold up their wings high above their bodies, and the moths spread them out flat.

QUESTIONS.

What name is given to the changes which insects undergo?
Mention the order of these changes?
What may be found on cabbage-leaves?
What comes from these eggs?
Describe the changes of the caterpillar.
What creature does it become, and how does it differ from the caterpillar?
In what situation does the gnat lay her eggs?
How does she guard them from being destroyed?
What becomes of these eggs?
Mention the changes they pass through before becoming gnats.
To what insects do the largest caterpillars found in our gardens belong?
How may moths and butterflies be distinguished?

Lesson XXX. *Winter-sleep of Insects. Usefulness of Insects.*

During winter very few insects are to be seen. The butterflies, the wasps, and most others, perish, and those that survive fall into a torpid state. Spiders roll themselves up in a thick shroud of web, and are found lying apparently dead, but are easily revived by removing them to a warmer situation: and heaps of torpid beetles are met with in places suited for their preservation. The pupæ of butterflies occupy crevices in bark, or are buried deep in the ground; some of them naked, and others wrapped in garments of beautiful silk. The larvæ of cockchafers, dragon-flies, and others, may be found, each carefully protected, and in places fitted for their wants.

The care which God takes of all his creatures is singularly shown in the modes in which the eggs of insects are preserved from cold or wet. Some are deposited, by a parent who never felt the cold, deep in the earth; others are placed on twigs and branches, but never on the perishable leaves; and others are found covered with a thick coating of water-proof varnish, or with down taken from the mother's body.

Insects are of the most extensive utility. We are too apt to consider them as troublesome;

but this is an error. Beetles and cock-roaches may be called the *scavengers* of the insect world, as vultures are amongst birds; and they clear away vast quantities of decaying vegetables and dead animal matter. Besides this, the valuable colouring matter called *cochineal* is the dried body of an insect; a small beetle, called the Spanish fly, is employed in medicine for raising blisters; and silk is furnished by another insect whilst it is undergoing its *transformations.*

The silk-worm, like the young of many other insects, changes its skin several times; and when it has arrived at its full size, it spins itself a web as a covering. The outer part of the web is coarse and irregular, but the inner lining is of fine silk, and in regular threads. The inclosed worm and its web is called a cocoon: this is placed in a hot oven, for the purpose of destroying the insect, which would otherwise, after a time, eat its way out, and thus spoil the web. After this the silk is wound off, and by various processes made fit for being manufactured into the most beautiful fabrics. If the cocoon were left uninjured, in the course of a short time a moth would issue from it. Silk forms a very important article of commerce, vast quantities being used for dress and other purposes.

The more we examine the insect world, the

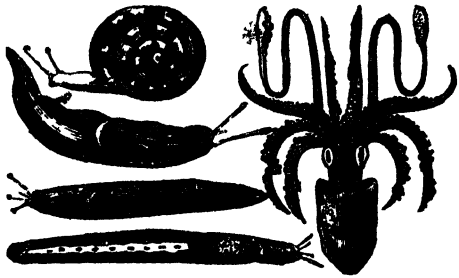
more sensible do we become of the mighty power and goodness of God. No portion of the animal kingdom is filled with more beautiful instances of His care and protection: in place, therefore, of looking upon the numberless "creeping things," which beset us on all sides, as objects of disgust or terror, or as noxious and useless creatures, let us watch and admire them. The humblest beetle that is seen traversing our garden-walks, and the smallest fly that sports in the summer breeze, alike fill some important and essential part in the animal economy. Let us never forget that

> . . . . Each crawling insect holds a rank
> Important to the eye of Him who framed
> The scale of beings,

and with this impression on our minds we shall always find in the natural history of insects abundant sources of instruction and amusement.

QUESTIONS.

How do insects generally pass the winter?
In what state are beetles and the larvæ of other insects found?
What precautions are taken to preserve the eggs of insects from cold and wet?
What insects may be called insect-scavengers?
What services do they perform?
What is cochineal?
What is the use of the Spanish fly?
What insect furnishes silk?
Which is the finest part of the silk?
What is a cocoon?
Why is the insect destroyed, and how is this done?
What would proceed from the cocoon if uninjured?



Lesson XXXI. *Invertebrate Animals. Cuttle-fish ; Polypi.*

The animals we have now to describe have, as the reader has been told, lately been divided by naturalists into several distinct classes, but as they are distinguished from other animals by being without a backbone, it will be convenient to consider them together under the name of the Invertebrata, or soft-bodied animals.

Mammalia, birds, fishes, and reptiles, have all a regular system of bones, or skeleton, and their bodies are covered ; but the Invertebrata have no skeleton, and their bodies are generally soft and naked. Their flesh is white, and they are cold to the touch. Shell-fish, snails, slugs, leeches, worms, polypi, and zoophytes, are included among the Invertebrata, as are also insects, by some naturalists.

These animals, like other cold-blooded creatures, are very tenacious of life, and suffer the most severe injuries without being destroyed, and many of them can exist for long periods, without food, and almost without air.

Some of these creatures are provided with *feelers* or *tentacula*, which generally surround the mouth, and some have a foot for motion. The *tentacula* can be moved about in all directions, and serve the same purpose as the *antennæ* of insects. The cuttle-fish has eight of them, with which it catches its prey, or defends itself; in this singular creature they are very strong, and of considerable length; and what is very curious, they are furnished with numerous little cups or suckers along their inside, which enables the animals to cling fast to anything they are applied to. The cuttle-fish grows to a great size, and becomes very powerful. It generally lies hid in holes of rocks, with its arms stretched out in all directions, ready to seize anything that may pass its abode. It has also a strong pair of jaws, with a beak like a parrot, and it is covered with a tough coarse skin, looking like leather. It possesses a bladder filled with a black fluid, which it can throw out at pleasure, and thus hide itself from its enemies. This fluid, when dried, forms a valuable colour, which

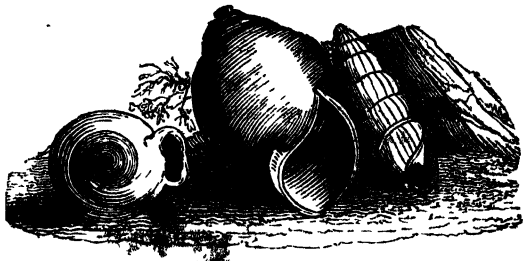
is much used by artists. The kind of cuttle-fish, engraved at page 142, is common on our coasts, and a bony substance or plate found in its body, is used for making tooth-powder.

Snails have horns or feelers growing out from the top of their heads, and at the ends of these, in some species, the eyes are placed.

The structure of many of this class of animals, as the Polypi, is so simple, that we cannot discover any particular organ, except a cavity which is supposed to be their stomach. They seem to be nothing but a mass of soft jelly-like substance; and were it not that they move about, one might imagine they were only pieces of some inanimate matter. Yet myriads of these creatures fill the waters, and are placed there for some useful and important purpose, though what that purpose is we may not fully understand. For the Lord hath done nothing in vain, "and the earth is full of His goodness."

QUESTIONS.

What creatures are called Invertebrata?
In what respects do they differ from the other classes?
What colour is their flesh in general?
Are they tenacious of life?
Describe the cuttle-fish.
How does it hide itself from its enemies?
Where are the eyes of some snails placed?
What is remarkable in the structure of polypi?



BIVALVE SHELLS.

LESSON XXXII. *Habitations of the Invertebrata; Shells; Pearls; Habits.*

A GREAT number of the Invertebrata dwell in a hard covering, called Shell. The colour of shells is, in some instances, remarkably beautiful, and their shape and structure very singular. The animal, as it increases in size, enlarges its dwelling, by adding fresh layers of matter at the edges; and, if the shell is injured, it is repaired with the greatest nicety.

Such shells as are in one piece, as that of the snail, are termed *univalve* shells, and those which have two plates, as the oyster, *bivalve* shells. Bivalve shells are usually fastened to the body of the animal by muscles, and by these it is enabled to open or shut them at pleasure.

Pearls are procured from a bivalve shell-fish: they are found growing in shells in many parts of the world, and even in some of our own rivers. The principal fishery for them is at the island of Ceylon, where vast numbers of shells are brought up by divers from the bottom of the sea.—Mother-of-pearl is the inner lining of the shells, freed from the rough outside crust.

Some invertebrate animals live on the land, and others in the water. Those which dwell on land breathe by a contrivance somewhat like our lungs; and those which inhabit the water have *gills* like fish.

The mode by which these creatures keep themselves in a state of rest is highly curious. This is done, in may of them, by means of a *sucker*, which is a soft muscular body, like what is called the foot or belly of the snail. It is astonishing how fast many fix themselves by this means; but whenever we are on a rocky sea-shore, we may easily prove the fact by endeavouring to gather limpets. Others hold themselves by a kind of glue, or cement; and many shells are actually fastened to rocks by a stony matter, so that their inhabitants never move from one spot.

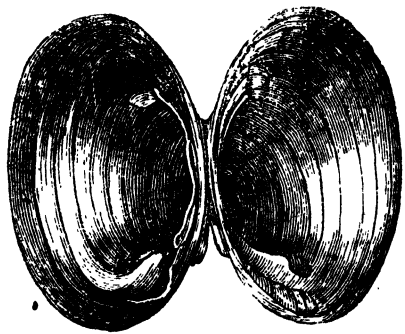
The motions of this part of the animal kingdom are slow, and confined to creeping and swimming. One or two of the bivalve shell-fish can,

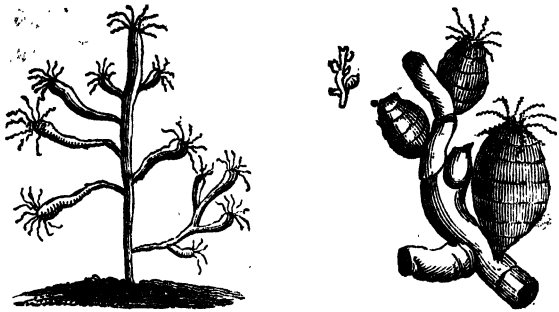
however, leap very short distances, — as the scallop, and the mussels found in our rivers.

Many of this class of animals afford excellent food, and are eaten in all parts of the world. The *Pinna*, a bivalve shell-fish, is famous for furnishing a kind of silky fibre, which is sometimes made into gloves and other small articles of dress.

QUESTIONS.

What kind of covering have many invertebrate animals?
In what way do they enlarge their shells?
What is the meaning of bivalve and univalve shells?
From what are pearls procured?
Where are they found most abundantly?
What is mother-of-pearl?
How does the snail support itself when at rest?
By what means do other animals fasten themselves?
Are they capable of much and quick motion?
What shell-fish can leap?
Which are useful as food?
For what is the pinna celebrated?





ZOOPHYTES.

Lesson XXXIII. *Zoophytes; Coral; Coral Reefs; New Islands; Sponges; Madrepores.*

A very singular portion of the animal kingdom consists of sponges, corals, and other objects, which have been called Zoophytes, or animal-plants. This name has been given to them because many resemble vegetable productions very closely; and there are others amongst them that have a likeness to masses of stone or rock.

Some of these zoophytes are fixed to the bottom of the sea by a kind of root, and grow very much in the same way as plants. They multiply, also, by nearly the same means,—that is, by buds and slips; and as they never move

from one spot, and give very little sign of feeling, they are often taken for sea-weed. They are, however, perfect animals of their kind, and are provided with tentacula, or feelers, which they employ to catch their food.

Others of these minute creatures, which have the common name of Polypi, dwell together by millions, and, with a sort of stony matter which they procure from their own bodies, they build for themselves a range of strong habitations, which we call Coral. Each of these little masons has, however, its own house, in which it dwells separately from its neighbours. These creatures are furnished with a number of delicate feelers, which are almost constantly stretched out in the water, and in active motion. A specimen is engraved at the head of this lesson.

The "great deep" has no wonder more striking than the formation of coral reefs by these habitations. In warm climates, they are seen rising, like strong walls from the bottom of the sea, and forming immense circles. The little architects carry on their labours till their buildings are above the surface, when they are exposed to the influence of heat and air. This causes the coral to crumble, and it thus becomes a bed for vegetation; seeds are borne there upon the winds, or by the tide, or brought by some wandering

bird which has sought the reef as a resting-place. Thus God, working by such apparently insignificant agents, is continually producing new islands, which, in the course of time, become covered with soil, and fit for the habitation of man.

Sponges, which grow plentifully on the rocky shores of the Mediterranean Sea, are also polypi. These, in place of covering themselves with stone, have a soft, fleshy dwelling, and this forms what we call sponge. Others amongst them bore holes in rocks, and some make a hard mass of stone, having but little regularity in its shape, and without being branched like coral. These are termed Madrepores, Millepores, and Retipores, names given them as descriptive of their dwellings.

QUESTIONS.

Why have certain animated beings been called zoophytes, or animal plants?

To which kingdom of nature do they in reality belong.

In what manner do some of these grow?

With what have they been confounded?

What are they furnished with for seizing their food?

What is coral?

In what climates are coral-reefs found?

In what form do they frequently appear above the surface of the ocean?

What takes place when they are exposed to the influence of air and heat?

How are the seeds of vegetation brought to coral-reefs?

What follows in the course of time?

Describe the mode in which new islands are produced?

What is sponge?

Lesson XXXIV. *The Vegetable Kingdom; Structure of Vegetables; Leaves.*

We now come to the second of the "Kingdoms" into which the productions of nature have been arranged, namely, the *Vegetable Kingdom.*

The term *vegetable* is applied to trees, shrubs, grasses, fungi, mosses, ferns, and lichens. It is these which clothe the earth with verdure, and cover it with woods and forests; and which supply a great part of the food of man and of the rest of the animal kingdom.

As we have before said, the objects comprised in this division live, but the life they enjoy differs from animal life. Vegetables can neither move nor feel: they grow and perish in the same situations, and though they appear sensible to light and heat, they show no trace of feeling beyond this.

The structure of vegetables is highly curious, and consists of woody fibres, and a number of narrow tubes, through which is conveyed a fluid, called the *sap.* The outer bark of plants or trees is in general hard and rough, and serves as a protection to the parts beneath. These are, an inner fibrous bark, and a layer of soft wood, called *alburnum.* Then comes the solid wood, which serves as a support for the whole, and in

the centre of this, there is, in some species of plants, a soft matter called the *pith*; these parts may be clearly seen in the young branch of an elder-tree; while the stalk of other species is hollow.

The leaves of vegetables are of very various shapes, and serve in a great measure to distinguish one species from another. The upper surface of leaves is in general smooth and glossy, and of a much deeper colour than the underside; this may be observed in the laurel, the willow, and many other trees, and plants.

Leaves differ, too, very much in size. In some plants, they are large, broad, and numerous, almost hiding the branches, as in the sycamore, and the horse-chestnut; in others they are small, long, and narrow, as in the ash and the willow. Some leaves are simple, that is, in one piece, as in the poplar; in others, each leaf-stalk holds several small leaves, called leaflets, as in the rose-tree; such leaves are named by botanists compound leaves.

Leaves form the *foliage* of plants; and are found to be set upon the branches in particular directions, according to the species. Thus, if we examine the leaves of the elm, or the ash, we shall find them arranged in one certain form, which is just alike in every branch we can find.

In the weeping-willow, the long and slender leaves are pendent, or hanging; whilst the common willow, though its leaves are very similar in shape, has them standing upright.

Leaves are made of a number of very fine nerves and veins, which lie all one way in grasses and some other species, but in general form a delicate thready net-work, filled up with soft pulpy matter. This structure may be seen, by picking up in autumn the leaf of a poplar. After this has lain for a time, it loses the soft pulp, and becomes a sort of skeleton, like very fine net-work. Leaves serve the same purpose in the vegetable kingdom, that lungs and other contrivances for breathing do amongst animals. The air, when confined over a plant, is found to undergo certain changes, and if not frequently renewed, the plant dies. Thus a free circulation of air is shown to be as needful to the life and health of vegetables as of animals.

QUESTIONS.

What objects are included in the vegetable kingdom?
Do vegetables live?
To what do they appear sensible?
What is the structure of vegetables?
Describe the parts of a vegetable as they may be seen in a branch of elder.
Are leaves alike in size and shape?
What are simple leaves?
What are compound leaves?
What is the foliage of plants?
Of what are leaves composed?
What purposes do leaves serve?
Is a free circulation of air essential to vegetable life?

Lesson XXXV. *Roots; Seeds; Buds.*

That part of a vegetable which is concealed underground is termed the root, and consists of a number of what we may call branches: these shoot in all directions deep into the soil, and thus serve to keep the tree in an upright position. These branches divide and subdivide till the extreme twigs or *radicles*, are as fine as threads, and it is through these that vegetables are nourished. For this purpose they take up, or absorb, moisture and other matters, which are then carried by the tubes into the trunk to the leaves, where they undergo a process which fits them for nourishing the plant.

Roots sometimes extend many yards along the ground, more especially if they are placed in rocky situations, where the soil is scanty, and only to be found in the fissures and crevices. In such cases, they shoot over broad spaces of bare rock, and penetrate every hole where soil can be found. When an ash or oak tree has been planted in such places, the roots may be seen straggling in all directions, in appearance like knotted branches, and clinging firmly to surfaces where we might suppose it impossible for them to find support. Roots have different names given to them according to their shape: long

roots, like the carrot, are called tap-roots; thick fleshy roots, like artichokes and dahlias, tubers; and solid roots, like tulips, bulbs.

The seeds of vegetables afford striking proofs of the power and wisdom with which they have been designed. The pulpy or eatable part of apples, pears, and plums, is but the intended seed covering. Some seeds, as beans and peas, are shut up in pods; others, as nuts, plums, and apricots, are inclosed in a hard shell; and others, as the oat and grass seeds, have a thick and tough membrane as a coating. Some leaves contain seeds beneath a thin skin, which breaks, and lets them out, to be scattered by the wind at seed time. The elm-leaf affords an instance of this.

When seeds are sown, after a time, a number of delicate roots spring from one end, and a green spout, or bud, from the other. What is very singular in the vegetating, or growing, of seeds is, that in whatever direction they may happen to fall, the root always strikes downwards, and the bud, which contains the rudiments of the future plant, appears above the surface. This is a kind provision of Providence; for, if every seed required to be placed in its proper position, there would be no possibility of sowing grain. As it is, however, if a seed fall

with the root-end uppermost, when the fibres have grown a little distance, they turn downwards, and the sprout which was growing into the soil, turns upwards, and makes its way above-ground. Those seeds which are shut up in hard cases, as nuts, when the sprout begins to grow, gradually enlarge, and the shell divides, to permit the young plant to make its escape.

Buds, which are found on trees during winter and spring, evince as much design as any object in nature. The bud of the horse-chestnut, for instance, early in spring, will be found covered on the outside, by a gummy varnish, which protects the tender parts inside from wet and cold. Beneath this is a strong and thick casing of leaves, and enclosed within these is a complete plant in miniature, consisting of a number of small downy leaves, curiously folded, and lying in the least possible compass. Most other buds are similarly protected.

QUESTIONS.

What part of vegetables is called the root?
What purpose do roots serve?
How is a plant nourished?
Name the different kinds of roots.
Mention some of the coverings of seeds.
What takes place after seeds have been sown some time?
What is very singular in the vegetation of seeds?
How will a seed grow when thrown root-end uppermost?
What are buds, and what do they contain?
Can you describe the bud of the horse-chestnut as it appears in spring?

LESSON XXXVI. *Flowers:—Structure of Flowers; Size of Flowers; Odour; Flora's Clock.*

FLOWERS are amongst the most charming of all the productions of nature. Their colours and forms are beautiful, and their odours are delightful. The bounteous hand of God has scattered them over the whole world, so that, go where we will, we are sure to meet with them, and to be pleased with their varied beauties.

Almost all plants produce flowers; and these are not only ornamental, but they are also necessary for the production of seed, the seed-vessels being in every instance part of the flower. In

admiring flowers, therefore, we should look at them closely, and we shall learn much that will make us sensible of the great care bestowed upon their structure. We shall also learn that flowers are designed for other purposes than merely to please the sight or smell.

The flower of that beautiful annual, the sweet-pea, so common in our gardens, is very remarkable, and in some degree looks like a butterfly. This delightful flower has four petals, as the coloured flower-leaves are called. The lowest of these, which is named the keel, encloses the seed-vessel; over these are stretched two others in the shape of a sloping roof, called the wings; whilst, towering over all is a broad petal, termed the standard or banner, which serves as a sort of vane; and, as the flower is placed upon a slender pedicle, or flower-stalk, it is thus enabled to turn away from the wind whichever way it may blow.

Flowers are found of all shapes and sizes. Some are so small as hardly to be visible to the naked eye; others grow to an immense size, as the Krûbûl, which is found in some hot countries. This is the largest flower at present known, and measures a full yard across; its petals are each a foot long, and the *nectarium*, or honey-vessel, is large enough to hold three

quarts; the engraving at the head of the present lesson represents this huge flower. A specimen of a nectarium may be seen in the columbine. In this flower it has the form of a curved horn or spur.

The odour or smell of flowers is in general exceedingly grateful. That of the hawthorn, which covers the hedge-rows with its white blossoms, is wafted to us on the earliest gales of spring. The mignionette, or little darling, the polyanthus, stock, wall-flower, rose, and many others, shed their fragrance through our gardens; whilst others are found in our spring and summer walks, through every lane and "alley green," affording a constant source of delight.

One of the greatest curiosities in the structure of flowers is, that many of them close their petals, or leaves, punctually at certain hours of the day, and others on the approach of rain. From observing this periodical shutting of flowers has been formed what is called Flora's clock. The yellow and purple star of Bethlehem closes at noon; the purple goat's beard shuts at twelve o'clock, and has thence been named, Go to bed at Noon; whilst the evening primrose opens its petals at sunset and closes them at daybreak. During summer, the dandelion opens about half-past five in the morning and shuts at ten, when

the sun is becoming powerful; the flower of the garden lettuce spreads its petals at seven, and collects them at ten; the cat's-ears closes at three in the afternoon; the mouse-ear at half-past two; and the prince's leaf at four, whence it is called, the four o'clock flower. Most flowers also close up their petals at the approach of night.

The pimpernel, or, as it is familiarly called, the poor man's weather-glass, is an excellent guide as to the weather. If its petals are seen fairly opened, it is almost sure to be fine; and if closed, rain is certainly near. Linnæus, the celebrated botanist, is said to have had so perfect a knowledge of the periods of the opening and closing of flowers, and of the signs given by them, that he wanted neither watch, calendar, nor weather-glass.

QUESTIONS.

Can you name the use of flowers?
Try to describe the flower of the sweet-pea, first, what it is like, and so on.
How is this protected from injury by the wind?
What is the largest flower known, and to what size does it grow?
In which of our garden-flowers may the nectarium be seen?
What flowers are remarkable for their delightful odour?
What very interesting circumstance is connected with many flowers?
What name has been given to this shutting of flowers?
Can you mention some instances of this?
What is the pimpernel called, and what may be learnt from observing its flowers?
What has been said of Linnæus and his knowledge of flowers?

LESSON XXXVII. *Periods of Flowering. Diffusion of Seed.*

OUR beneficent Creator has, in his bounty, ordained that every season should have its peculiar vegetation. He has thus given to us a constant succession of new and beautiful objects, and clothed the earth with plants fitted for the changes in our climate.

There is hardly any time of the year in which some flowers may not be found; they are few in the depth of winter, plentiful in spring and in summer, and gradually decrease in number during the autumn.

One of the earliest of our spring-flowers is the yellow hellebore, or Flower of St. Paul, which generally appears early in January. This is followed by the snowdrop, and by the spring crocuses, anemones, butter-burs, and liverworts. Then come the yellow colt's-foot, and the daisies, which at the end of February are seen covering whole fields with a carpet of flowers; then, too, the little golden stars of the pilewort are spread over banks and sloping glades in profusion.

In March we have the sweet violet, the polyanthus, the red and yellow crown imperial, the primrose, the dog's violet, variegating every

bank and hedge-row. About the middle of this month, the mezereon, the almond, and the peach embellish our garden walls, with their delicate pink blossoms, and the early plum throws out a perfect snow-wreath of white flowers.

In April and May, the earth is almost covered with floral beauties. The dandelion gives its golden tint to our meadows, and the furze and broom to our heaths and waste places; whilst the buttercup, the cowslip, and field hyacinth, the "drooping harebell blue," wall-flowers, peonies, and London-pride, are found in all directions. The hedge-rows and gardens are crowded with blossoms of the black and white thorn, the plum, the cherry, the pear, the apple, the honeysuckle, and the lilac; and the fields with poppies, pansies, violets, and different grasses.

June brings us lilies, irises, pimpernel, foxglove, mallow, sweet-williams, pinks, larkspurs, bindweed, or convolvulus, and wild and garden roses, as the dog rose, the Scotch, the cabbage, the moss, the musk, and the downy-leaved roses. July ushers in marygolds, amaranths, hollyhocks, sweet-peas, lupins, snap-dragon, corcopsis, lavender, and nasturtiums. August, the sun-flower, ragworts, starworts, docks, burdocks, China-asters, and dahlias. September is accompanied by the whole family of fungi, such as mush-

rooms, toad-stools, and puff-balls; and by chrysanthemums, and meadow-saffron, and the Michaelmas daisy, so named from appearing generally about the end of the month.

At the beginning of Autumn the petals of flowers have fallen away, and fruit and seeds ripen. The means provided by God, in order to secure the diffusion or spreading of the seed, are amongst the most singular of His works, and show the most beautiful design, with the means for fulfilling it. The different coverings, or seed-vessels, may be called sowing-machines, and they perform their work in an admirable manner. Some of them, when they have become dry, burst open suddenly, and scatter the seeds all around, as we may observe in the balsam and the heart's-ease; others are so light that they are carried by the wind, and many are provided with little feathery balloons, by means of which they are wafted away. During the time the thistles are shedding their seeds, on some occasions, the air is almost filled with them, as they are provided with a tuft which carries them on the breeze; and the seeds of the ash, the fir, and sycamore, have wings, and are blown away in hundreds to very great distances.

The seeds of mosses and fungi are so light and small that they are carried up into the

air along with the evaporation of moisture, and floated over rivers and seas, to be left on rocks and barren places as the first beginnings of vegetation. Many seeds, as those of the burdock, the bedstraw, the agrimony, and others, are covered with little hooks, and are by this means carried away by the skins of animals. If we look at our dress after an autumnal walk through a copsewood or thicket, we shall find it covered with seeds, sticking by these little hooks. How little are children aware, as they blow away the seeds of dandelion or stick burs upon each other's clothes, that they are scattering seeds.

The number of seeds to a plant is generally very great, and they furnish a large portion of their support to many birds, besides the vast quantity used by man for various purposes.

QUESTIONS.

At what periods of the year are flowers most plentiful?

What is one of the earliest spring-flowers?

Can you tell what flowers appear in great numbers in February?

What flowers come with March, and what trees blossom?

Are flowers abundant in April and May?

Name some of them, and the fruit-trees, which are full of bloom

What flowers appear in June?

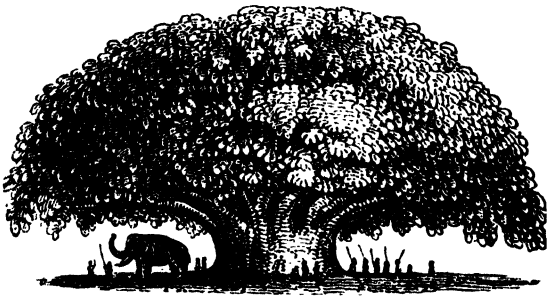
Name some of the flowers July, August, and September bring to us.

At what period do plants mostly shed their seed?

Mention some of the ways in which seeds are scattered abroad.

What seeds are furnished with wings?

By what means are seeds carried away on the skins of animals?



THE BAOBAB TREE.

LESSON XXXVIII. *Trees; their Uses.*

THOSE vegetable productions which grow to a certain size, and have a distinct trunk or stem, are called Trees. Shrubs differ from trees merely in being smaller, and having a bushy character, and from several stems often springing together from the same spot.

Trees serve for a great variety of useful purposes. The timber, or wood obtained from them, is used for the building of ships and houses, particularly oak, teak, and pine, or deal. The ash, the beech, the elm, the lime, the poplar, and the birch, amongst our native trees, are of great value to the cabinet-maker and the carpenter. The fruit of the oak, called acorns, and the fruit of the beech, called beech-mast, were used for food in former times, when our country was

covered with forests, and in some places these fruits are still collected for feeding hogs. Pines or firs grow to a great height, and are used for the masts of ships and for building. Turpentine, rosin, pitch, and tar, are procured from these trees.

The largest and most magnificent trees are, however, found in hot countries. Among these, various kinds of *palms* afford the noblest specimens of the Vegetable Kingdom. They attain a vast height, the *palma real* of Cuba often being seen one-hundred and sixty feet high. They have tall, slender stems, without branches, with a crown of immense leaves springing from the very top, and hanging down in the most graceful manner. These leaves are twelve or fifteen feet long, and have at their stalks bunches of the most brilliant blossoms.

Most of the palms bear fruit, which supplies the people where they grow with the greatest part of their food. The date-palm and the cocoa-nut palm are amongst the most useful, and their fruit is also made an article of commerce.

The baobab, or monkey-bread tree, a native of Africa, is the largest vegetable known. From its enormous size, and noble appearance, it well deserves the title of the Monarch of the Forest. This tree has a short stem, but it is of amazing

thickness, and from this it sends out branches till it resembles a forest in itself: its fruit is highly valuable, being used both as food and medicine. The engraving at the head of the present lesson represents this magnificent tree.

In South America, a tree has been lately discovered which yields a juice like milk in appearance, and which forms a nourishing drink: hence it has been called, Palo di Vica, the cow-tree, or the mother-tree. India rubber is the dried juice of another South American tree. This is obtained by cutting into the bark, from which the sap flows plentifully of a milky whiteness. It is then exposed to the sun, which dries it; and this is all the preparation it undergoes.

Some of the trees found in hot countries are useful to the natives, by furnishing them with water. The wild pine of Campeachy has deep leaves, which are so made as to hold water: these are filled during the heavy tropical showers, and serve both to refresh the plant and as drink to the traveller. Another tree of the same nature is found in one of the Canary Islands, which is almost destitute of water; and others in the East Indies.

The wood of many of our English trees is of a very beautiful colour, and takes a high polish. Mahogany, rose-wood, zebra-wood, ebony, and

many other foreign woods, are used for ornamental furniture.

The cotton-tree, however, affords one of the most valuable vegetable productions. It is a shrubby tree growing in warm countries, and produces a nut, in which the seeds are covered by the soft downy substance called cotton. Vast quantities of this are gathered every year, and the making of it into cloth employs many thousands of our countrymen.

QUESTIONS.

In what do shrubs differ from trees?
Mention some trees which are useful for building.
What trees are chiefly used by the cabinet-maker and carpenter?
In what countries do the finest trees grow?
What tree affords the finest specimen of vegetation?
Can you describe a palm tree?
What kinds of trees furnish dates and cocoa-nuts?
Mention two useful South American trees.
What kinds of woods are used principally for ornamental furniture?
What plants yield the most useful vegetable production?

COFFEE TREE. TEA PLANT.

Lesson XXXIX. *Fruits; Grasses; Garden and Field Vegetables.*

God, in his bounty, when providing seed-vessels for many vegetables, covered them with rich pulpy and nourishing matter. This we call fruit: it is of the utmost value to us as food, and in many instances as medicine.

We cannot turn, indeed, to any portion of the three kingdoms of nature without finding some object to remind us of the goodness and bounty of our universal Father. The bud or the leaf of a plant is as full of instruction as the form and structure of the elephant or the whale.

The apple, the pear, the plum, the cherry, the peach, the apricot, the gooseberry, the currant,

the raspberry, the strawberry, the filbert, and others, grow abundantly in our country. In warmer climates, the orange, the lemon, the olive, the grape, the fig, the date, the bread-fruit, the pine-apple, the melon, and a great variety of others, grow in endless profusion, and afford to the inhabitants a wholesome and grateful provision fitted for their peculiar wants. The engravings at the head of this lesson represent filberts, raspberries, and grapes.

The *grasses*, or Cerealia, as they are termed by botanists, form one of the most important and most useful families in the vegetable kingdom. It is these which cover the earth with verdure, and it is these which form the principal part of our vegetable food. Wheat, barley, rye, oats, maize, or Indian corn, millet, and rice, are included among the grasses, and furnish man with bread, and its substitutes, in all parts of the world in which they grow.

What is commonly called *grass* consists of a number of plants, all remarkable for their slender stems, their thin and delicate leaves, and for their mode of flowering. One of their most valuable and singular properties is, that the more they are eaten away and apparently injured, the more they flourish, as this strengthens their roots, and makes them grow with double vigour.

This eminently fits them for feeding cattle, which derive their entire support from them.

Some grasses, which are small in our country, grow to a great size in hot countries, and are found taller than a man, covering vast plains. The inhabitants of warm climates are supported in a great measure by rice and maize, whilst in colder countries man lives chiefly on wheat and oats. The sugar-cane, from the juice of which sugar is procured, is another of the grasses. The bamboo, reeds, and rushes, which are applied to many useful purposes, are also members of the same family.

Great numbers of vegetables, useful as food, are cultivated in our gardens and fields. Amongst these are cabbages, brocoli, beans, peas, asparagus, cauliflowers, turnips, carrots, potatoes, and many others. The potato, which now forms so necessary a part of our diet, has only been known amongst us about two hundred years. Onions, leeks, garlic, parsley, beets, and radishes, are grown in gardens, and are called with the rest culinary, or garden, vegetables.

Most of the vegetables that we have mentioned are used by man for food; but, besides these there are many which are raised by him for various other purposes.

Flax is cultivated for the purpose of making

linen; hemp for ropes and matting; rape for oil; and hops for brewing. Clover, lucern-grass, vetches, Swedish turnips, and others, are cultivated for feeding cattle; and saffron, woad, and madder, for the purposes of dyeing cloth; the first yields a yellow, the second a blue, and the third a red colour.

QUESTIONS.

What is fruit, and for what purposes is it useful?
What kinds are common in our country?
Name some of the fruits that abound in hot countries.
What plants cover the earth with verdure?
From what do we derive the principal part of our food?
What is it which is commonly called grass?
What remarkable property is possessed by the grasses?
Upon what grains do the inhabitants of hot countries chiefly live?
Mention some other useful plants of the family of grasses.
Enumerate some of the principal garden vegetables.
For what purposes are flax, hemp, rape, and hops, cultivated?
What vegetables are cultivated for feeding cattle?
Name the dyeing plants.

Lesson XL. *Mosses; Fungi; Ferns; Lichens; Sea-weed.*

The reader has been told that most plants produce flowers. There is, however, one portion of the vegetable kingdom, on which flowers are never seen, and this embraces mosses, fungi, or the mushroom tribe, lichens, ferns, and sea-weeds. A bed of moss consists of a great number of very small and very beautiful plants. Rocks, coral-reefs, swamps, bogs, and other situations, where larger vegetables would not grow, are sometimes covered with moss; these, by their decay, form a stratum, or layer of soil, which in course of time becomes planted with the seeds of grass and other herbs; and thus barren places are made fertile, by the agency of these apparently useless objects.

Fungi are those fleshy bodies which are found so plentifully upon decaying wood, in damp and shady places. Many of them grow to a considerable size, and exhibit very beautiful colours. Great numbers of these curious vegetable productions may be found by examining an old wood-heap at the beginning of October. They are very useful in hastening the decay and removal of dead wood, as it is upon this that the greatest part of them live. Mushrooms,

toad-stools, puff-balls, fairy-purses, and many other plants of similar kinds, are very common in our fields and about the roots of trees in autumn.

Some of the fungi, as mushrooms, morels, and truffels, are used for food; others are poisonous; and we should be very careful not to eat any but such as we know are fit for food: many accidents having happened to children, from a want of proper caution. The seeds of mushrooms are very numerous, and grow in the gills, as they are termed, that is, in the ribbed part on the under side of the head or cap. It has been calculated that several million seeds are contained in a single fungus. One kind has the property of ejecting its seed with great force and rapidity, and with a loud cracking noise: yet it is no bigger than a pin's head.

Ferns are among the most graceful productions of the vegetable kingdom. They are found adorning shady lanes, and woody slopes, with their slender stems, and delicate foliage. Nothing can exceed the beauty and delicacy of the half-unrolled leaves of a young fern, and we should never pass one without pausing a moment to admire it, and to wonder at the wisdom displayed in its fine structure. In hot countries ferns grow thirty or forty feet high,

appearing like trees; and they produce their seeds by millions. The roots and stems of this species of plants, when ground, are said to afford a very tolerable food.

In very cold countries, where corn and other field-vegetables will not live, the ground is covered by lichens, and mosses. The care of Almighty God has left no place, however bleak, without some means of supporting animal and vegetable life; thus the lichens afford nourishment to the rein-deer in those inhospitable regions, where it is the only animal that can exist, and where it supplies nearly all the wants of the inhabitants. One species of lichen, called Iceland moss, is used among ourselves, both as food and medicine; and from many others valuable colouring matters for dyeing are extracted.

The bottom of the sea is clothed with vegetable productions. These are called sea-weed, and in some situations it grows so plentifully as to cover the surface of the ocean, and give it the appearance of a vast field. Sea-weeds afford food to marine animals, and some kinds are burnt for soda, which is used for making soap and glass, and for many other purposes. Other kinds are in some countries used for food, and many are spread over the land as manure.

The number of these flowerless plants is very great, and although they have till lately been little noticed, and their real structure is still little known, yet there have been distinguished upwards of eight hundred species of mosses alone, two thousand five hundred lichens, and five thousand fungi, besides the ferns and sea-weeds. Many of these plants, the mosses and ferns especially, are extremely beautiful, and to the attentive observer manifest the wisdom and power of their great Creator equally with the noblest tree of the forest.

QUESTIONS.

What plants do not produce flowers?
In what situations do mosses grow?
What important purpose do they serve when decayed?
What are fungi, and on what do they live in general?
Name some of the fungi.
Why should we be careful in eating fungi?
In what countries do ferns attain a great size?
In what countries do lichens grow most abundantly?
What useful animal finds its principal food from lichens?
Is the sea provided with vegetable productions?
What are the uses of sea-weed?

Lesson XLI. *The Mineral Kingdom.*

All the natural objects which have hitherto been noticed, have life, although its nature differs widely in the various classes we have described: they are found in the early stages of their existence, small in size, then growing larger, living a certain period, and in the end dying. Minerals differ from these in having no life: they are found in large masses, and undergo scarcely any change in the course of ages.

We have also seen that an All-wise Creator has placed both animals and vegetables in peculiar situations, and that they are found differing in form and habits, according to climate. This is not the case with mineral bodies. As far as the nature of stone and metals is concerned, they are nearly the same in all countries. Volcanoes, which are minerals in a state of combustion, burn in the same manner, and with the same results, in the very hottest and in the very coldest countries.

The mineral kingdom forms what is called the crust of the earth, and includes rocks, metals, chalk, coal, sand, salt, and other bodies. What is termed the soil, or that soft covering which serves for the support of the vegetable kingdom, is made up of decayed animal and vegetable

matters, and of minerals, which have either been broken into small fragments, or reduced into powder.

When we examine it, we find the mineral kingdom is as full of the beauty of design, and shows the handiwork of God as forcibly, as the most finished animal or vegetable. The different parts of which it is composed are arranged in a certain and definite manner, which is the same in all situations, and in all climates.

Our own country is particularly favoured in the number and valuable nature of its mineral productions. These are, indeed, some of our chief sources of wealth, as without them we could not carry on our great manufactures. They are also important articles of commerce, a number of ships being constantly employed in conveying them to other countries; in which they do not exist, or where the inhabitants have not skill or industry to procure them. Amongst the most important mineral productions of our country may be reckoned coal, iron, lead, tin, copper, limestone, clay, slate, building-stone, and salt.

Almighty Wisdom, in laying the foundation of the world, has placed the different parts of the mineral kingdom in regular order, one kind of rock, stone, sand, or clay, being always laid

above the other: these layers are called *strata*, and the order of their succession is invariably found to be the same wherever they have been examined.

In some of these strata, the remains of animals, such as bones and shells, are found in great abundance, and in others, those of vegetables in immense quantities; these are known under the name of *fossil remains*, which signifies that such substances have been changed into stone. What is very singular about these remains is, that rocks with the remains of sea shell-fish and other sea animals imbedded in them are now found on the tops of lofty mountains; yet these must, at one period, have been at the bottom of the sea, and have been carried to their present situation by the waters of the Deluge, when, in the language of the Bible, the "waters prevailed exceedingly on the earth; and all the high hills that were under the whole heaven were covered."

QUESTIONS.

In what do minerals differ from animals and vegetables?
Are minerals found to be of the same nature in all situations?
What bodies are included in the mineral kingdom?
Of what is the soil composed?
Name some of the most important of our own minerals.
In what kind of order are minerals arranged?
What are fossil remains, and where are they found?
What is singular as to the situation in which some fossil remains are found?
How is this to be accounted for?

Lesson XLII. *Metals; their Properties and Uses.*

Metals form one of the most important parts of the mineral kingdom. They are found in the earth, lying in *veins*, or narrow beds, generally in fissures of hard rock. Sometimes they are nearly pure, but more commonly mixed with other mineral bodies, and in this state are called *ores*, as lead-ore, iron-ore, and copper-ore.

Metals are the heaviest bodies with which we are acquainted. This may be easily proved by taking a piece of iron and a piece of stone, or any other substance, of the same size, in each hand; they are also lustrous or shining, often sonorous, and can be bent without breaking.

Some of the metals, as gold and silver, more particularly, may be extended or drawn into very fine wire, and beaten into leaves much thinner than the finest paper. A single ounce of gold may be spread by the hammer over a surface of one hundred and fifty square feet, and yet remain quite whole, without the least flaw or hole in it; and the same quantity may be drawn into a wire more than a hundred miles long. All metals can be melted, or *fused*, by heat.

The place from which metals are procured is termed a *mine*. Mines often run to great dis-

tances underground, and the miners are exposed to serious dangers at times, from a want of a free circulation of air. When the ore has been dug out and brought to the surface, it has to be freed from the impurities which are mixed with it: this is done either by reducing it to a coarse powder, and washing it repeatedly, when the water carries off the lighter particles, and leaves the metal behind; or it is roasted, that is, mixed with coal and burnt. This removes most of the impurities, and it is then smelted and made fit for use. Iron, especially, undergoes several tedious processes before this is accomplished.

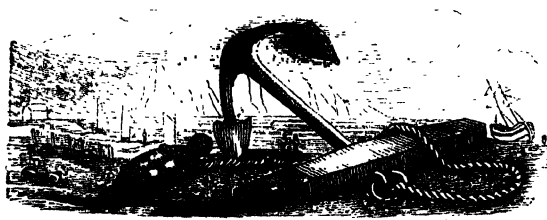
None of the productions of nature are more useful to man than the metals. Of them are made alike articles of minute and vast size; from the fine needle to the huge anchor, such as is engraved at the end of this lesson. In all the arts of life, and in all our manufactures, metals are indispensable. Implements required to be hard, durable, and flexible, are usually made of metal. Most vessels that have to be exposed to the action of fire, are made of the same material, as is every cutting instrument, where a fine edge is necessary.

Wherever we look around us, indeed, the utility of metals is apparent. Some of them, besides being extensively employed in the arts,

and for domestic purposes, are *coined* into money. Gold and silver are the most important of these, and in all civilized countries are employed by buyers and sellers. Commerce is chiefly carried on by their means, and by the exchange of one article for another, the value of each being first calculated by the quantity of gold or silver it is worth. Copper also is largely used amongst ourselves and other nations, for coin of inferior value.

QUESTIONS.

Where are metals found?
What are the beds called in which they lie?
What name is given to metals when found in an impure state?
Name some of the properties of metals.
What metals are the most extensible?
Mention some instances.
To what danger are miners exposed?
By what methods is the ore freed from impurities?
Are metals indispensable in most of the arts and manufactures?
Name some of the uses to which they are applied.
What metals are coined into money?



Lesson XLIII. *Iron, Copper, Tin, and Lead.*

Of all the mineral bodies which God has provided for our use, iron is the most universally valuable. The purposes to which it is applied are almost numberless. By its means, man chiefly supplies his wants, as without it agriculture could never have arrived at any perfection, nor the plough have rendered the earth fertile. It is also essential in the preparation of other metals, mining-tools of all sorts being made from it; so that were it not for iron, the mineral stores of the world would not have been available to us.

The greatest part of our manufacturing machinery is constructed of iron; and it is largely used at the present time in building houses, mills, and bridges, and in making rail-roads and steam-engines: stoves, cannon, knives, scissors, saws, scythes, and cutlery of every kind, are likewise made from it.

Steel is iron which has been made red-hot in a charcoal fire. This may be hardened to any degree, by being heated, and then suddenly cooled by plunging it into spring-water. The *temper* given to steel by this process is so great, that a sword properly prepared will cut through iron or divide a hair.

Iron ore is found in many parts of the world, and abundantly in England. In no country is it so valuable as in our own, because we have coal and mechanical contrivances, such as are known to no other people, for procuring it, and converting it into useful forms.

The loadstone, or natural magnet, is an ore of iron. This possesses very remarkable properties, and is capable of transferring them to any piece of iron or steel on which it is rubbed. Artificial magnets made in this manner are very common, and it is highly interesting to observe how they attract, or draw towards them, needles and other articles made of iron, and to feel how fast they hold them. One of the most singular and valuable properties, however, of the magnet is, that when properly prepared, and nicely balanced, one end always points to the north. The needle contained in the mariner's compass is an artificial magnet.

The iron trade has long been one of the staple trades of our country, and employs a numerous body of labourers and artisans. Nearly a million tons of iron are annually wrought in Great Britain, some part of which is exported; but by far the greatest portion is used in this country. We also send almost two millions' worth of hardware and cutlery to other countries every year.

Copper is another metal which is applied to many useful and domestic purposes; boilers, kettles, and pans, being made from it. Some care is required in using copper. If acids or fruits are put into vessels of this metal, they should be well cleaned afterwards, or a green substance or salt will be formed on them, which is poisonous. For this reason copper pans are usually covered with tin. Brass is a compound, or alloy, as it is styled, consisting of copper and another metal called zinc. Bronze is composed of copper and tin.

Tin, which is found almost exclusively in England, is procured in great quantities from the mines of Cornwall and Devonshire. It is an important article of commerce, as we supply nearly the whole world with it. Considerable quantities are used for covering sheets of iron, which are then termed block-tin, and are employed in making cans, saucepans, kettles, and many other domestic utensils. Pewter is an alloy of tin, lead, and other metals; and was formerly extensively used for making dinner plates and dishes.

Lead, of which there are many rich mines in Yorkshire, Derbyshire, and Wales, is employed for spouts, water-pipes, and cisterns, and is rolled into sheets for covering the roofs of churches

and other large buildings. For this purpose it is better fitted than many other metals, as it is not liable to be so much injured by the air. Bullets are cast from lead in moulds; and small shot is now made by first melting a quantity, and then pouring it into an iron vessel pierced with holes, and placed at the top of a high building; from this it is allowed to fall to the bottom into water, and in its descent it assumes a round shape.

There are several preparations of lead, which are of important use in manufactures; one of these is white lead, which is largely used in preparing paints; others are used in medicine; and red lead, or minium, is employed in enamelling, in glass making, and in many other processes.

QUESTIONS.

What mineral body is the most universally useful?
How is iron necessary to make other minerals available to us?
Name some of the uses to which iron is applied.
What is steel, and how may it be hardened?
Mention how far it may be *tempered*.
Why is iron more valuable to England than to other countries?
What is the magnet, and what properties does it possess?
What value of hardware and cutlery do we export every year?
Why is care required in the use of copper vessels?
In what part of England is tin found abundantly?
Why is tin an important article of commerce?
What is block tin?
For what purpose is lead chiefly used?
Can you tell how small shot is made?
Name some other preparations of lead.

Lesson XLIV. *Coal, Sulphur, and Naphtha.*

Coal is another mineral body, deserving particular attention. Our country owes the chief part of her wealth to having extensive beds of this substance under her soil. Our manufactures never could have existed without it; and we find our principal manufacturing towns, as Manchester, Sheffield, Glasgow, Leeds, and Birmingham, in the neighbourhood of coal-mines.

The great value of minerals in Great Britain arises from her abundance of coals, as this enables us both to bring metals up cheaply from the greatest depths, by means of the steam-engine, and to refine them when they are brought to the surface. Other countries have coal-mines as well as Great Britain, but not so plentifully, or so well fitted for the same purposes.

Coals have been divided by mineralogists into three classes; first, black coal, which includes all our common fire-coals, as cannel-coal, slate-coal, and others; second, coal which burns badly, or uninflammable coal, as culm or stone-coal; and third, brown coal.

Coal and wood, though so different in their appearance, are much of the same nature. Coal-fields are indeed the remains of vast forests, which

have at some distant period been buried under the surface of the earth, and in the course of time changed into this mineral. When we examine pieces of coal, procured from some of our mines, the shapes of many kinds of plants can be discovered in them. Some of these impressions are very beautiful, and so perfect, that the particular plant can be easily named.

Coals are found lying in beds, or strata, and always with strata of certain other mineral bodies. By boring some little distance into the earth we soon ascertain whether there is coal in that particular situation, for if we meet with one of these bodies, it is quite certain that coal is below.

This mineral is called combustible, which signifies capable of supporting flame, that is, of being made into fires. Besides being the food of our manufactures and commerce, vast quantities are used as fuel for domestic purposes, and contribute greatly to our comfort. In London alone, nearly two million chaldrons are annually consumed; and in all England, upwards of fifteen millions. This amazing consumption, we might suppose, would exhaust the mines. Of this, however, there is no likelihood; as it has been calculated that we have a supply under our soil for four thousand years; besides which, in many parts of the country, there are immense

beds of peat and other vegetable substances, which are slowly undergoing a change into coal.

Sulphur is another combustible body, which is exceedingly useful in various arts. Great quantities are found about volcanoes, as Mount Ætna, Mount Vesuvius, Mount Hecla, and in Mexico. It is an important article of commerce in these countries. Gunpowder is made in part from sulphur; so is sulphuric acid, or oil of vitriol, which is largely used in bleaching, hat-making, tanning, and dyeing.

Naphtha and petroleum are two combustible bodies, also belonging to the mineral kingdom. They are found in various parts of the world, either floating on the surface of water, or forming actual springs. They are very inflammable, and burn like oil in lamps.

QUESTIONS.

To the possession of what mineral does Great Britain owe much of her wealth?

In what situation are our principal manufacturing towns found?

Mention some of these.

What is the reason that minerals are so valuable in England?

Have other countries coal like our own?

Name the classes into which coals have been divided.

What class furnishes our common fire-coal?

Are coal and wood much alike in their nature?

What are coal-fields?

What do we often find when we examine pieces of coal?

How many years is it supposed our present supply of coals will last?

In what situations is sulphur plentifully found?

What acid is made from sulphur, and for what purposes is it used?

Are there any other combustible bodies in the mineral kingdom?

LESSON XLV. *Rocks; Granite; Limestone; Freestone; Slate; Clay; Salt.*

MOUNTAINS and hills are, in general, masses of rock of various kinds. Some of these tower to great heights, rising many thousand feet above the level of the sea. One kind of rock, called granite, is very hard, and of this some of the highest mountains are composed. The hardness and toughness of granite has caused it to be used for laying down roads, as it lasts much longer than other kinds of stone; the pavement, the curb-stones, and the carriage-ways in London are in most instances of this rock, which has been brought chiefly from Scotland. London Bridge and Waterloo Bridge are built of granite, and some other public buildings are also of the same substance. Granite takes a fine polish, but is very difficult to work.

Limestone forms many mountainous ranges in England, as in Derbyshire, Somersetshire, and Yorkshire. This kind of rock often contains lead-ore, and is so full of fossil remains, principally sea-shells, that it would seem to be almost entirely composed of them. Limestone, when burnt in a kiln with coal, becomes lime, which is largely used in agriculture, for spreading over the ground; when slaked, or thrown into water,

it becomes hot, and crumbles into a white powder, of which are made mortar, and the whitewash with which many of our rooms are coloured. The different kinds of marbles are beautiful varieties of limestone. Many kinds are found in England, but the finest and best are imported from Italy and Greece.

The most useful stones for building are free-stone and sandstone. Granite, which is the most durable, is so difficult to work, that it is very expensive; but the Portland-stone is soft when taken out of the quarry or stone-pit, and may be cut very easily, by a saw, into blocks of a proper size; when it has been exposed some time to the air, it hardens.

Slate-rocks are found abundantly in Wales, Cumberland, and Yorkshire. This kind of rock occurs in thin layers or plates, which readily separate, and form the slates with which our roofs are covered.

Clay is found lying in vast beds under the soil of many countries. It is generally stiff, somewhat tenacious, and capable, with the addition of a little water, of being moulded into a variety of shapes. Clay is of very great utility. Bricks, for building houses, are made from it.

All kinds of earthenware are made from a clay called potter's clay. England is particularly

famous for her manufacture of earthenware, and one large district in Staffordshire is named the Potteries, from its being almost covered with works devoted to this purpose.

Common salt, which is of such importance to us as a seasoning for our food, and is also used in many of the arts, is found either dissolved in water, as in salt-springs and sea-water, or in solid masses, as rock-salt. This last is dug out of the earth like other minerals; the salt is procured from springs and from sea-water, by allowing the water to evaporate. England is both rich in salt-springs and in salt-mines, and they are also plentifully found in many other countries.

> These are thy glorious works, Parent of Good,
> Almighty! thine this universal frame,
> Thus wondrous fair! and loudly these proclaim
> Thy goodness.

QUESTIONS.

What are mountains and hills?
What kind of rock forms some of the highest mountains?
Why is granite so useful in road-making?
From whence has the granite been chiefly brought with which the streets of London are paved?
Which of the bridges over the Thames are built of granite?
In which countries does limestone form ranges of hills?
Of what does limestone seem principally composed?
To what uses is limestone applied, and how is it prepared?
What is marble?
What are the most useful building-stones?
What is the structure of slate-rocks, and what are their uses?
What name is given to that part of England where earthenware is principally made?
In what states is common salt found?
How is it procured from sea and from salt-springs?

LESSONS

ON THE

STRUCTURE, SENSES, AND HABITS OF MAN.

LESSON I. *Of Man.*

MAN, who in the beginning received from his Creator "dominion over the fish of the sea, and over the fowl of the air, and over every living thing that moveth upon the earth," was also endowed by Him with higher powers, and a structure of a superior kind.

Man is the only creature on our earth that habitually walks erect. This position of the body enables us to look forward, or around us, with ease, and gives us an appearance of authority and dignity.

Man is the only being possessed of hands. By the aid of these organs he performs a multitude of wonderful and delicate operations, beyond the reach of other creatures: he builds houses, tills the earth, makes clothing, constructs the most curious machines, and applies them to an endless variety of purposes. The mechanism of

the human hand is widely different from the paws of other creatures. Animals of the monkey tribe approach the nearest to us in this respect, and are called quadrumanous, or four-handed: but their thumbs are exceedingly imperfect, compared with ours, and their hands are altogether fitted for different purposes.

The noblest gift, however, which has been bestowed upon man by our bountiful Creator, is THE SOUL; an intelligent and immortal principle, including the mind and affections. It is this which raises us above all other animals, for it enables us to love God, to reason, to think, and to compare. It is this which makes us charitable, generous, and humane; which gives us taste and ingenuity, a sense of right and wrong, and above all, of Religion. Hence we see on every side, places of public worship, hospitals for the sick poor, manufactories, and courts of justice. It is this, also, which makes man, though naturally the most defenceless of creatures, the most powerful, and capable of overcoming "everything that moveth on the face of the earth."

Most animals are provided with some outward means of defence. Oxen have a thick and tough skin covered with hair, and horns and hoofs; the tortoise has its armour of shell; and the lion its teeth and strong claws. Man has nothing

whatever of this kind, but his reasoning faculty enables him to take measures by which he may protect himself from the fiercest and strongest among other creatures, and either destroy them or employ them for his own benefit.

It is the soul also which displays itself in our speech,—which enables us to improve ourselves, to acquire knowledge, and to become wise, learned, and good. How different from ourselves is man in a savage state! how rude his habits! how ignorant he is! and how few are his wants! yet this man, having a soul and reason, may, by care, be raised to our own level.

This is not the case with brutes. The bird built its nest and the mole burrowed out its underground dwelling, in the very earliest ages of the world, as perfectly, and in the same manner, as at present; and they will continue to do so as long as the several species shall continue to exist, without change or improvement.

QUESTIONS.

Which is the superior of all animals?
What is the proper posture of man?
Has any other creature beside man hands?
Are the hands of monkeys capable of being applied to the same purposes?
What is it that raises man so much above other animals?
Mention some of the effects produced by mind.
Which is naturally the most defenceless animal?
By what means, then, is man enabled to protect himself?
How may the savage be civilized and improved?
Do inferior animals undergo any change in their habits?

Lesson II. *General Structure of the Human Body.*

Our body is a wonderful piece of machinery, perfect in all its parts, curious in its arrangement, and admirably fitted for our peculiar wants. We have going on within us at all times an infinite variety of singular operations, such as digestion, nutrition, secretion, and circulation; and yet we are not sensible of them, although there are thousands of vessels at work; some removing superfluous parts, some laying down fresh matter, some carrying black blood, some red blood, some bile, and some watery fluids.

The heart contracts and expands, and sends a stream of fresh blood through our bodies, seventy or eighty times every minute. The lungs are filled with fresh air, and this air comes back changed above a thousand times every hour; and all these things are done so gently, and by parts so perfectly made, that were we not told of the wonders within us, we should be in ignorance of their existence. Let us, however, inquire into them; and an examination of our own frames cannot fail to increase our love of God's goodness, and our admiration of His Almighty wisdom and power.

Our bodies consist of solid and fluid parts.

The fluids are by far the most plentiful. The body of a full grown native of the Canaries, where the people formerly exposed their dead in open places to be dried by the sun, has been found weighing not more than twelve pounds, though the bones and other solids were quite perfect; yet this body must have weighed at least one hundred and twenty pounds when living, or in its natural state.

Most of our organs are double. Thus we have two eyes; the nose is divided; the tongue consists of two parts; the neck has a set of muscles and vessels on each side; we have two arms and hands; two legs and feet; and the brain consists of two divisions. These double parts are very similar in their structure.

Those organs by which we move from place to place, and eat, drink, and perform manual labour, and other actions, are under our own government or will: that is, we can employ them or not, just as we choose; hence they are named *voluntary*.

Other organs, on the constant action of which our very life depends, are not under our own government. The heart, the stomach, the lungs, the intestines, and other parts, act, whether we are waking or sleeping, whether we wish it or not; and on this account are called *involuntary*. Over

these our Creator has given us no power, or our lives would be in continual danger, as our passions or negligence might prove our destruction.

The whole body is covered with skin, which serves as a protection to the delicate and sensitive parts beneath. The outer skin is so thin that we feel through it. Its importance as a defence against pain is soon known when a portion of it is removed by a blister or by any other means; we cannot then bear anything next to the part; even the very air gives us pain.

All the parts of our body are held together by a fine membrane or web; called from its form, the cellular membrane, as it is made up of a number of very small cells. This makes the parts play easily one over another, and lets them distend, or swell out without injury. It is also through this that vessels and nerves pass from one part to another.

QUESTIONS.

Mention some of the operations constantly going on within us.
Are we sensible of these operations?
What kinds of fluids circulate in our vessels?
How often does the heart act in a minute?
How many times are the lungs filled and emptied in an hour?
Of what are our bodies composed?
Are the solids or fluids most abundant?
What is remarkable about our organs?
What parts are called voluntary, and why?
What parts act without our knowledge or will?
Of what use is the skin, and how may we prove its use?
How are the different parts of the body held together?

LESSON III. *Organs of Support and Motion; Bones; Joints; Muscles.*

CERTAIN parts of our bodies are very hard and firm: these are called bones, and consist, in a great measure, of earthy matter. When these are jointed, or articulated together, they form the skeleton.

The form and make of the skeleton are beautifully perfect, and fitted to our system with the most surprising art; so far is the skeleton from being an object to cause terror, that the more we examine it, the more we shall find to admire in it.

The bones form the frame-work of the body, on which the soft parts are arranged and supported. They are held together by means of ligaments, which are strong whitish bands, and commonly called gristle.

The ends of bone, where they meet, are covered with a substance somewhat like gristle, and called cartilage. This is very elastic, or springy, and preserves the bones from being injured by the shocks and motions of our bodies. That they may move easily one upon another, they are furnished with glandular bodies, which keep them constantly smooth by means of an oily fluid. The places where bones meet are

called joints, as the shoulder-joint, the elbow-joint, the wrist-joint, the knee-joint, and others.

The number of bones in the human body is about two hundred and sixty. They are divided into, the bones of the head; of the trunk, or body; of the upper extremities, or arms; and of the lower extremities, or legs. Their shapes are very various, some being long, round, and hollow, as those of the thigh, the leg, and the arm; others are flat, as the shoulder-blade, the breast-bone, and the bones of the head; and others are in small rounded pieces, as those of the hands and feet.

Bones are very soft in infancy, only part of them being then ossified, or made into bone. As we grow older, and have occasion to use our limbs for motion and support, the bones harden; and about the fifteenth year of our age are perfect.

Muscles are the organs or parts by which we move our bodies. What we call flesh is muscle, and this consists of a number of fibres, or little threads, bound together in bundles, by the cellular membrane, and a strong sheath on the outside. One of these bundles forms a muscle. Muscles are fastened to the bones by a tough strong substance, which seems to grow into it.

We have the power of shortening and lengthening our muscles at will, and thus producing

motion. For example, when you stretch out your arm, this is done by contracting the muscles at the back of the upper arm, which arise above the elbow-joint, and are fixed into the bone below it. When these are contracted or shortened, therefore, they pull the arm backwards, or stretch it out. For this reason they are called extensors, or extending muscles.

Now, when you bend your arm, the motion is performed by contracting the muscles on the front of the arm. These are fixed at their upper ends above the elbow, near the shoulder, and at their lower ends just below the elbow. When these are contracted, they pull the arm upwards, and thus bend it. On this account they are called flexors, or bending muscles. The motion of the other parts of our bodies is effected in a similar manner.

Muscles, before they terminate, or are fixed into the bone, are generally reduced to a thick cord of white glistening substance, which is very strong, and is called tendon, or sinew. Where this passes over joints, it is bound down by a strong band, to keep it in its place when the muscle is acting, and to preserve the shape of the parts.

The power with which muscles contract is very great, and is termed irritability. Our

voluntary muscles soon become tired, and require rest; those which are involuntary are in perpetual motion, and are never fatigued, but keep acting, without rest, from the hour of our birth to that of our death.

QUESTIONS.

Of what do bones chiefly consist?
What name is given to all the bones when put together?
How are the bones held together, and what are their ends tipped with?
What are joints, and by what means are they kept smooth?
What is the number of bones in the human body?
At what age are our bones completely hardened?
What organs enable us to move our bodies?
Of what are muscles composed?
By what means is motion produced in muscles?
Can you describe by what means your arm is bent and stretched?
What are extensor muscles?
What are flexor muscles?
What are the ends of muscles called?
What difference is there in the action of voluntary and involuntary muscles?

LESSON IV. *Standing, Walking, Running, Leaping, Sitting.*

THE principal actions which our bodies can perform are, standing, walking, running, leaping, and sitting. Besides these, the hand and fingers are capable of a wonderful variety of minute and delicate operations; and the muscles of other parts of our bodies, as the face, the throat, and the eyes, have each a great variety of motions peculiar to themselves.

How do you stand? Your body is erect, and you keep yourself from inclining either to one side or the other. If it were the will of God that you should die in this posture, you would fall down at once; or if any other cause should deprive you of strength, or if you should fall asleep, or forget yourself, the same thing would follow.

Standing is, therefore, an action of the voluntary muscles; you wish to stand, and that enables you to do so. The extensors, by acting on the bones, keep the limbs and trunk erect, whilst the flexors yield and make no efforts to contract. By these means, we are enabled to retain an upright posture. But we are soon fatigued by it. This is owing to there being no change of action, one set of muscles only being employed. Hence, when we are obliged to stand for a long time, we frequently change our posture, now resting on one leg, and then on the other. This is done in order to relieve the muscles from their state of continued action, by calling others for a moment into play.

Walking is easier to us than standing still; for this reason, that both sets of muscles, namely, the flexors and extensors, act now one and then the other, and thus are constantly relieving each other.

When we walk, one leg is lifted and carried forwards; at the same time, the whole weight of the body is made to rest on the leg that is planted on the ground; the leg which has been carried forwards is fixed on the ground, and the body is shifted upon it, by the strong muscles of the trunk and thigh-bone; and so on alternately. Thus, what is called the centre of gravity,—or the point on which the greatest weight falls,—is borne by turns upon each limb, and we move forwards step by step.

Running and leaping are varieties of the same action; as when we run, we make a succession of short leaps. These differ from walking, inasmuch as in walking the body always rests on one limb; whilst in leaping and running, it is for a time raised above the ground, and carried forwards by the impetus, or force, which has been given to it.

Now, how is this managed? When we wish to leap, we bend our body forward, the trunk on the thighs, the thighs on the knees, and the knees on the ankles. In this state, we exert violently all the extensors, or stretching muscles, of these parts, as well as those of the arms; and such is their power, that they lift us up, and throw us to very considerable distances. When we run fast, our bodies acquire so much velo-

city, that we cannot stop at once, as we can in walking, but are obliged to check ourselves by degrees.

Sitting is a half-standing posture. When we sit, the weight of the trunk and head is taken from the legs, and we rest on two bones, cushioned in muscles, and hence called the sitting bones. In this posture, the upper part of the body is kept erect by the muscles of the neck and back.

It is highly useful and necessary to exercise ourselves in walking, running, leaping, and other actions, requiring the use of our muscles. By these means they become stronger, and capable of more exertion, and we are less liable to fatigue. These exercises, when reduced to a system, are called Gymnastics; but we should be careful not to over-exert ourselves in its practice, many injuries and accidents having arisen from a want of due caution.

QUESTIONS.

Is standing a voluntary action?
What order of muscles keeps us erect?
Why do we so soon feel tired by standing?
Why is walking easier to us than standing?
How do you walk?
How do running and leaping differ from walking?
Can you tell how you manage to leap?
What muscles lift us up by their action?
What benefit do we derive from exercising our bodies?
What is this exercise called?
Why should we be careful in exercising?

Lesson V. *Vessels of the Human Body in general: Arteries; Veins.*

Nothing is more surprising than the vast number of vessels, filled with different kinds of fluids, which crowd our bodies in every part. If we prick ourselves with the finest needle, blood is sure to follow,—a proof that it has wounded some vessel.

Vessels are tubes having thin yet strong coats. One set of vessels carries the blood from the heart—these are called arteries; another set receives it, and carries it back—these are called veins; a third takes up the nourishing juices from our intestines—these are called lacteals; a fourth set rises from the surfaces of the joints and other places, and removes the fluids which are poured out into them—these are called absorbents; a fifth set covers the surface of the body, the mouth, the linings of other great cavities, and is always exuding or secreting fluid to keep them moist—these are called secretory vessels.

How wonderful it is, and what a source of grateful reflection should it furnish, that we can run, jump, and perform other violent exercises, without disturbing the action of these thousands of delicate organs!

The arteries are the vessels which convey blood from the heart to all parts of the body. One great artery arises directly from the heart. This artery, which is called the aorta, is very large. Before it has gone far, however, it forms an arch; and, in its progress down the body, sends off divisions to all the parts which it passes. From the arch arises the carotid artery, which divides into two in front of the neck, and supplies the head with blood.

When the aorta reaches the lower part of the back-bone, it divides itself into two large vessels, one of which goes downward to supply each of the lower limbs. These branches, as they pass along, keep ramifying, or dividing, till they are so small, that we can no longer trace them.

Every thread of muscle, and the coats of the arteries themselves, are thus abundantly provided with small vessels; nay, so full of blood-vessels are the muscles, that their red colour is owing to them.

The large arteries are very carefully protected from injury, and generally lie buried deep amongst the muscles. Were they to be cut, we should soon bleed to death. There are some parts, however, as the wrist and the elbow, where they have to pass over joints, and where they must come near the surface. We should

be careful about these parts, as many accidents have happened from boys playing carelessly with penknives.

If an artery is pricked, the blood springs from it in jets, and is of a bright florid vermilion colour. When we put our finger upon an artery, it is found to beat; this motion or pulsation, as it is called, is readily to be noticed at the wrist.

Arteries, when they have divided into the smallest branches, and reached the extreme parts of the body, end, by inosculating, or meeting mouth to mouth, with the beginnings of veins. These carry the blood back through the lungs to the heart, as it has become changed in its qualities during its progress through the system, and requires to be renewed.

The coats of veins are much thinner than those of arteries, and they are provided with valves to assist the blood along them, and prevent its flowing backward. The blood passes along the veins slowly, and is of a dark colour. When a vein is opened, its contents escape in a quiet stream, and not in jets or leaps, like those of an artery. The blue lines which we see under our skin are veins. These continue to enlarge as they approach the heart, and end in very large vessels, which pour the blood into one of its parts.

QUESTIONS.

What proof have we that our bodies are full of vessels?
Mention the names of some of these vessels.
What are arteries, and of what service are they?
Does more than one great artery rise from the heart to supply the body?
What becomes of it?
In what manner are the great vessels protected?
How does blood flow from an artery, and what is its colour?
Can you tell how veins begin?
What vessels carry the blood back to the heart?
How does blood flow from a vein?

LESSON VI. *Nerves; Glands; Secretion.*

WHEN we examine the great blood-vessels, we generally find that they have lying near them white cords. These are nerves.

All nerves are connected either with the brain or spinal marrow. Like the arteries, they are large at their beginning, and as they remove from it, become smaller and smaller, by sending off branches. These end in the substance of our bodies, in filaments or twigs, so very small, that we should not know of their presence, were it not that the parts are sensible, or possess feeling.

Nerves are the organs by which we are made acquainted with the world around us. By their means, we feel, see, hear, smell, and taste. If the nerve supplying the tongue is injured, we can no longer perceive that what we eat has any flavour. If the nerve supplying one of the

fingers is cut through, that finger is no longer sensible; we may prick it, or crush it, and feel no pain.

Besides this, we can no longer move the finger, as the nerves are the medium by which we *will*, and call our muscles into play. We see that a person who labours under palsy, which is a disease of the brain or spinal marrow, from which nerves proceed, cannot move the affected limb, and has scarcely any feeling in it; it hangs down powerless and useless.

Every part of our body, except the hair, the nails, the bones, and some others, is full of nervous twigs or filaments. We cannot cut or scratch ourselves anywhere without feeling pain. We should not suffer this, were it not that a nerve is cut or torn.

We find in certain parts of our system, small roundish or oval bodies, abundantly supplied with blood-vessels and nerves. These are glands. When we have a violent cold and sore throat, many of these glands may be felt about the neck, as then they swell and become painful. The breast is also a gland, and there are many others in various places. When we examine them, we see many vessels going from them, which, in some instances, unite and form what is called a duct, or outlet.

These glands are the organs of secretion. A secretion, means a peculiar fluid made from the blood, as the saliva, the tears, bile, and others. The gland secreting the saliva lies on the cheek, just before the ear, and the duct opens in the inside of the mouth. The lachrymal, or tear, gland, is concealed in the orbit of the eye. When we weep, it secretes very copiously.

The tears are carried away through a little opening, which may be seen at the inner corner of the lower eyelid. This is the orifice, or mouth, of a duct leading into the nose, and hence called the nasal duct.

The secretions are very much under the influence of our feelings; thus, when we are in sorrow, we shed tears almost in spite of our will; and if we suffer severe pain, the same thing occurs, unless we have obtained a mastery over ourselves.

QUESTIONS.

What do nerves resemble?
With what parts are they all connected?
How is it that they become smaller and smaller?
How do they terminate?
By what means do we know that our bodies are full of nerves?
What is it that nerves enable us to do?
What happens if the nerves of the tongue or finger are divided?
Where may glands be felt at times?
What is meant by a secretion, and from what is it prepared?
Mention one or two secretions.
Are the secretions much under the influence of our feelings?

Lesson VII. *The Skin; Hair; Nails.*

The whole of our body is furnished with a covering called skin. The structure of the skin is very curious, and it is impossible to look at it without being reminded of the care which our Creator has bestowed upon us.

The skin consists of three layers, or coats. The outside one is called the *epidermis*, or scarf skin, and is very elastic. It is pierced with innumerable little holes, called pores, through which the hair passes, and the perspiration exudes. It is, moreover, quite insensible, and appears to have no blood-vessels. With great care, we may thrust a needle through it, and neither see blood, nor feel pain; and when we are scalded or burnt, or have a blister applied to us, it is seen raised in the form of a bladder. It is also half transparent, and shows the colour of the parts beneath it.

The epidermis is stretched over some of our limbs in little folds. Look at the joints of your fingers. Bend them, and observe how these folds disappear. Besides, where we cannot see any folds, the epidermis is capable of great extension. There is a disease called *emphysema*, and another, dropsy, in which it is stretched out very considerably; yet, when the cause is removed, it

recovers its tone, and after a time, becomes smooth as before, though at first it is much wrinkled.

By a wonderful provision of our Creator, the epidermis over those parts of our bodies which are most exposed to friction or injury, is very much thicker than at any other part, and the more it is thus exposed the thicker does it become, as may be seen in the hands of blacksmiths, and other labouring men.

Under the epidermis lies a second coat. This is very soft, and it seems rather to be a layer of *mucus*, or slime, than a distinct lining; and, for this reason, it is named the *rete mucosum*, or mucous coat.

It is this which gives colour to the skin, as the scarf skin itself is colourless in all nations. But very little of it is found beneath our own skins, our colour being chiefly owing to the parts under the skin. In the Negro, it is black and plentiful; in the native American, copper-coloured; and in the Malays, olive.

The next layer is the true skin, or *corium*; this is much thicker than the others, and quite spongy. It is made up of a net-work of arteries, veins, nerves, and secretory vessels.

This is the most sensitive part of our bodies; and we could not bear to be touched were it not

protected, and its sensibility blunted, by the epidermis, or scarf skin. When a piece of this last is removed, and the corium exposed, the vessels immediately secrete a thickish fluid, called lymph; into this new vessels shoot, and, in the course of a few days, it is changed into proper skin.

The facility, indeed, with which any but very serious injuries to the scarf skin are repaired, is very remarkable, and, though some persons may think little on the subject, furnishes a striking proof of the ever-watchful care of our great Creator. The inconvenience to which the loss for any length of time of the skin of a single finger even, would expose us, would be much greater than we should readily imagine, and accordingly no sooner has the accident happened, than it is remedied. This is also the case with the second coat, or colouring matter; but when the injury extends to the true skin, or corium, this tissue being much more complex in its structure, the original fabric is not restored, but in its place appears a tough material, bearing some outward resemblance to it, but by no means fulfilling its uses. This is the reason why deep cuts leave scars and lumps, which is never the case when the two outer coats only are injured.

The surface of our bodies is, in a great measure,

covered with hair. In general, these hairs are very delicate and small, and do not take away from the smoothness of the skin. The head, however, is thickly clothed, and there the hair grows long. Hair was doubtless given to mankind to serve, in some sort, as a protection against the weather. Every hair is a hard and elastic tube, growing from an oval bulb beneath the true skin.

The backs of the ends of our fingers and toes are covered and supported by nails. These are smooth, horny in their texture, and have no feeling. They are formed from a very tender part, called the root, and have a rapid growth. The mode in which the skin is folded under and around the nails, is exceedingly beautiful.

Nails are highly useful to us in touching and grasping bodies, and in walking, as they afford a firm support to the soft fleshy ends of the fingers and toes.

QUESTIONS.

What is the outside part of the skin called?
What is the blister we see when we are scalded or burnt?
Why do we see the colour of the parts below the epidermis?
What is the colour of our bodies owing to?
In what people does the colouring matter of the skin exist abundantly?
Of what is the true skin composed?
What is the most sensitive part of our bodies?
What purpose does hair serve?
Is hair a solid body?
From what do nails grow?
In what way are they useful to us?

LESSON VIII. *The Stomach and its appendages; the Intestines; the Liver, &c.*

As there is a constant consumption and destruction of parts going on in our bodies, it is needful that they should be regularly supplied with nourishment. For this purpose, we take food, and have a stomach and various other organs, fitted for changing it into a proper form for nourishing our system.

The changes which our food undergoes to prepare it, constitute what is called digestion; and the actual laying down of new matter by the different vessels, is called the process of nutrition.

The stomach is a long bag, placed just below the breast-bone, and lying partly across the body. It is large enough, in a grown man, to hold about three pints of fluid, and is joined to the mouth by a tube, or passage, called the gullet. The opening into this is seen lying quite at the back of the throat, and it receives the food after it has been crushed by the teeth, or masticated, and mixed with saliva. In this pulpy state it is passed into the stomach by the contraction of the gullet pressing it downwards.

After the food has remained in the stomach for a time, that organ begins to contract, and forces it through an opening into the intestines.

The intestines form one continued canal, or tube, about five or six yards long, lying in a wonderfully small space, and most curiously folded one upon another.

They have several coats or linings, the inner one being red, full of plaits, and covered with little eminences, termed *villi*, which give it a *velvety* appearance. These *villi* are the beginnings of the vessels which convey away the nourishing juice.

The outer coat of the intestines is smooth and shining, and always moistened by a watery fluid to keep it soft, and to allow the parts to move easily over each other.

Between these two coats is another, called the muscular coat. It is this which gives to the intestines a constant motion, something like that of a worm when crawling, and hence called *vermicular* or *peristaltic*; this motion enables them to push forward their contents.

Distinct names have been given by anatomists to different parts of the intestines, and the whole are divided into the large and the small. The small intestines receive the food from the stomach, and the useless parts are allowed to collect in the large ones, till it is proper and needful that they be discharged.

The liver is another part closely connected

with the stomach. It is a large dark-looking glandular body, filled with veins, and secretes a peculiar fluid, which is of a yellowish colour, and very bitter. This is bile. This fluid is collected in a little bladder seated under the liver, and called the gall-bladder. From this it is carried by a duct into the upper part of the small intestines, where it is mixed with the food. Its importance may be estimated from the fact that our food never digests well when the bile is too small in quantity, or its properties are changed by disease. In jaundice, the bile, in place of being poured into the intestines, is carried into the blood, and tinges the whole body with a yellowish hue.

There are several other glands in union with the stomach and intestines. These secrete various fluids, which serve some useful purpose in digestion.

QUESTIONS.

Why is it needful that we should take food?
What is the stomach, and where is it placed?
What do you call the passage connecting the stomach with the mouth?
What receives the food from the stomach?
Do the intestines form one continuous canal?
What is the appearance of the internal coat of the intestines?
To what do they owe their motion?
What is it called? what is its use?
How are they divided?
Can you describe the liver?
What organ secretes the bile?
What becomes of it?
Is it an important agent in digestion?
To what is the yellow colour of the body owing in jaundice?

LESSON IX. *The Teeth; Conversion of Food into Blood; Digestion.*

ALTHOUGH every portion of the human frame is "fearfully and wonderfully made," no part is more remarkable than the teeth; and none can more clearly show us how much wisdom and design have been bestowed upon our form by the Divine Architect of the universe.

If you look into the mouth of a very young child, you see no teeth. The gums are low and rounded, and show no marks of the great change that a few months will produce in them. There are, however, buried beneath them, two or more complete sets of teeth, each tooth shut up in a little bag, or capsule, and separate from the rest.

Now why is it that infants are without teeth? Because at this period of our lives we live upon milk and other soft diet, and because our stomachs are not fitted to receive food so solid as to require chewing. After a time, as we become stronger, and require different food, the teeth appear in regular order; first, the front teeth, then the side teeth, and lastly the double teeth.

The set of teeth which first appears occupies only part of the jaw, and is generally completed about the infant's second or third year. These

teeth are called the milk-teeth, and are shed, with the exception of six or eight, in the course of three or four years. Our bodies are now become stronger, and our mouths wider, and for this change God has provided.

At this time, the second, or permanent, set of teeth pushes forwards, and gradually displaces the others. This set, when complete, consists of thirty-two teeth, sixteen in each jaw; but they seldom all appear till we are fourteen or fifteen years of age, as there is not room for them before we have reached nearly our full growth.

That part of a tooth which stands up above the gum, is called the crown, and is covered with a very hard ivory-like substance, termed enamel. The roots of the single teeth, and the fangs of the double ones, are hollow, and contain a nerve, artery, and vein. The nerve, when exposed or inflamed, gives place to that distressing pain, called toothach.

The food which we eat to supply the waste in our bodies, is first submitted to the action of the teeth. These, by their hardness and sharpness, break it into small fragments, whilst the glands give out saliva in abundance.

By these means the food is made into a soft pulp, and in this state it passes into the stomach. When it is received there, the vessels of that

part throw out a fluid called the gastric juice. This is a very powerful solvent, and by mixing with the food, brings it into a half-fluid state, when it is called *chyme*, and is of grayish colour.

This change being finished, the lower opening of the stomach, which had remained fast closed whilst it was going on, opens and permits the chyme to pass into the small intestines. Here it is made still more fluid, by the addition of various juices, and becomes of a milky whiteness; it is now called *chyle*. In this state it meets with the *bile*, which is supposed to have the property of separating the nutritious from the useless parts.

The reader has learnt that the inner surface of the small intestines is lined by *villi*, which are the mouths of lacteals. These are now actively at work, taking up the milky part of the chyle, and carrying it to a number of glands, where it undergoes some further change.

From these it is carried forwards, till all the lacteals are at last collected into one large duct, which conveys the stream of chyle now fitted for mixing with the blood, along the spine, up as high as the neck; here it opens into one of the great veins, and after passing through the heart and lungs, becomes perfectly mixed, and ready for nutrition.

These are the changes undergone by our food before it becomes blood, and they come under the general term, digestion. Such parts as are not taken up are pushed along the intestines, and finally expelled.

QUESTIONS.

What is there concealed in the gums of infants?
Is each tooth separate, and in what is it enclosed?
Why have very young children no teeth?
In what order do the teeth appear?
What is the first set called, and how long does it last?
How many teeth does the permanent set contain?
At about what age are these commonly completed?
What is contained in each tooth?
What qualities has the gastric juice secreted by the stomach?
Can you tell the name of the food when mixed with this juice?
How is the food named in the small intestines, and what is it like?
What order of vessels then take it up?
Into what do these convey it?

LESSON X. *The Heart; Circulation of the Blood; the Blood.*

THE heart is a most wonderful piece of mechanism. At one moment it shuts itself and forces a stream of blood through all parts of our bodies, by means of the arteries; the next it opens and receives it back again from the veins; and these actions continue, night and day, throughout our lives, for if anything were to interfere with their regular succession, we should die immediately.

The heart is a hollow body, placed in the left side of the chest. Its broad end, or base, is turned upwards, and its narrow end, or apex, a little crosswise and downwards. It is enclosed in a loose bag or purse, in which its apex moves freely, striking against the side every time it contracts. It is this which we feel when we place our hand over the fifth and sixth ribs.

The heart is divided into four cavities, or chambers, which have thick walls of muscle, and it is into these chambers that the blood is received, and by these muscles that it is forcibly pushed out. Besides these, it has several very curious valves to keep the blood flowing in its proper directions. The heart may be called double, one part being employed in forcing the blood through the body at large, and another in forcing it through the lungs.

We have mentioned how our food is changed into blood; let us now see in what way the blood is passed to all parts of the system, for the purpose of nourishing them, and supplying the waste.

The heart is the great centre of the circulation, and is placed between the two sets of blood-vessels already described; namely, the arteries and veins. From these last, one of the chambers of the heart is filled with dark or venous blood, no longer fitted to serve the wants of the system,

and mixed with the chyle and other matters. This chamber then contracts, and forces the blood into a second and stronger chamber, which, in its turn, drives it through the lungs.

Here the blood gives off its impurities, and becomes arterial blood of a bright red colour. It then flows into a third chamber, and from this into a fourth, which is the most powerful of them all, and from which the great artery, the aorta, before mentioned, arises. Into this it is thrown with great force, and urged on into the extremities of the body.

These vessels are the feeders of the body, supplying it with what is needful; they end in minute veins: and the veins bring the blood again to the heart, which opens to receive it.

This is the round of the circulation, which is continued without stop or rest, and without any wish or action of our own, our all-wise Maker having placed it out of our control. This alternate shutting and opening of our hearts produces that motion in our arteries, called the pulse.

In childhood the heart beats upwards of an hundred times in a minute: in youth, about eighty, and in manhood, from sixty to seventy. In fevers and some other diseases it beats more quickly. There is no pulsation in veins.

Thus we see that the heart beats, night and day, at the rate of upwards of one hundred thousand strokes every twenty-four hours, without disorder and without weariness. It rests not; for were it to do so, the whole machinery of the body would stop, and the animal would perish. It was requisite to be made capable of working without the cessation of a moment. It is so made; and the power of the Creator in so constructing it can in nothing be exceeded but by His wisdom.

The blood, from which all our solid and fluid parts are formed, when it is first drawn from a vein or artery, in a person who is in a good state of health, resembles a simple liquid. After it has stood, however, for a little while, it coagulates, as it is termed, and separates into three very distinct parts. When we look at it, we see a red mass swimming in a straw-coloured liquid. This liquid is slightly viscid and salt to the taste, and is called serum. The mass is made up of two bodies: one a fine, thready matter, which is named fibrin, and the other of red globules, or little round bodies. The fibrin being heavier than the serum, falls to the bottom as it cools, and carries with it the globules. When we have a fever, or other illness, however, the appearance of the blood is greatly altered.

QUESTIONS.

Is the constant action of the heart necessary to our existence?
What is the heart, and where is it placed?
What part of the heart is it we feel when it contracts?
How many cavities are there in it?
By what means is the blood expelled from it?
Is our heart single or double?
For what purpose is the blood circulated through our bodies?
Try to describe the course of the circulation?
What produces the pulse, and how often does this beat at different ages?
Do the veins pulsate?
Describe the change the blood undergoes when taken from the body.

LESSON XI. *The Lungs and their Appendages; Respiration.*

ONE of the most important actions of our system is breathing. This is so essential to life, that if it be interrupted for a very short space of time, we die from suffocation. Breathing consists of two actions: *inspiration*, or drawing in the air, and *expiration*, or forcing out the air.

The lungs are soft, spongy bodies, full of very small hollows, called air-cells. The thorax, or cavity of the chest, in which the lungs are contained, is covered by the ribs and breast-bone, and is divided by a broad muscle, from the abdomen or belly. This muscle, which is named the diaphragm, is the great agent in breathing. There are also several other muscles, fixed to the ribs and other parts, which assist it.

The lungs themselves are in two divisions, lying one on each side of the chest, with the heart between them. These divisions are termed the right and left *lobes*.

When we feel the front of our necks, we find a hard body. This is a tube composed of cartilaginous or gristly rings, so that it is always kept open, and is named the *trachea*, or windpipe. It is through this that the air is conveyed to and from the lungs.

The windpipe opens at the back of the mouth, before the entrance into the gullet, so that all our food has to pass over it. How does it happen that our food does not get into it? Now and then, indeed, this does occur, and the accident is followed by the most serious consequences, and even by death.

When we are eating fast or carelessly a crumb will sometimes slip into what we familiarly call "the wrong way," that is, it gets in the windpipe. To prevent this constantly happening, the windpipe is protected in a very curious way. The opening into it is a narrow slit, called the *rima*; the part itself is named the *glottis*; and over the slit is fixed a moveable little body or valve, called the *epiglottis*; and this is so arranged, that whenever we are about to swallow, the motion of the tongue pulls down this cover-

ing, and closes up the opening with the utmost nicety.

How wonderful and beautiful this is, as we are not sensible of it; and if before swallowing we had always to think and exercise our will in shutting this aperture, how different would be the process of eating, and how frequently must accidents happen from our forgetfulness!

Why is it that breathing is so absolutely essential to our life? For this reason,—that the blood, in its passage through the body, is changed, becomes dark-coloured, and is no longer fit to support life. In this state it reaches the heart, and before it is sent back into the arteries, it is passed through the lungs. Here it is purified by exposure to the air, through the thin linings of the air-cells, with which the lungs are filled, and all of which communicate with each other, and with the windpipe. After this exposure, the blood becomes of a bright red colour, is taken back to the heart, and thrown into the body for its support.

The blood being thus changed, let us see what change has been undergone by the air in our lungs. If you put a piece of quill into the nozle of a pair of bellows and blow into a cup of lime-water, you will find no change in its appearance. You blow into it just the same

kind of air which you draw into your lungs. But if you put the quill into your mouth, and blow into the lime-water, you will see it become turbid and white, and if allowed to stand, a fine powder will fall to the bottom. The reason is, the air which you have blown into the water has passed through your lungs, and during its progress has lost a part of its oxygen, and in its place we find fixed air or carbonic acid. It is this which causes the lime-water to become white by uniting with it.

This fixed air is very unwholesome;—animals soon die if confined in it, and this is the reason why close and crowded rooms are so unhealthy, as the air becomes very impure, and unfit for breathing. We soon become oppressed and languid in these situations, and whenever we feel these symptoms, we should have the room ventilated, or remove to more open places.

QUESTIONS.

What happens if our breathing is interrupted?
Of what do the lungs consist?
What is the cavity called in which they are placed?
Which is the most important muscle in breathing?
What are the divisions of the lungs called?
How is the windpipe kept open?
Through what is the air conveyed to the lungs?
Endeavour to describe the way in which the opening into the windpipe is protected.
How is the blood purified in the lungs, and what colour does it become?
Is the air we have breathed changed?
What simple experiment shows the nature of this change?
What kind of air is formed in the lungs?

LESSON XII. *The Organs of Voice; Warmth of the Human Body.*

THE organs of voice are in close union with, and, indeed, form part of, the parts used for breathing. They are placed at the upper end of the windpipe, so that the current of air necessary to respiration passes through them.

If you feel with your fingers just below the chin, you find a prominence, which has a somewhat triangular shape; this in books is called the *thyroid cartilage*, and in common language not unfrequently Adam's apple.

This projection is one of five pieces of hard substance very curiously contrived and put together, and forming a hollow body, called the *larynx*, which incloses the parts producing sound. These are four small ligaments, called the *cordæ vocales*, which pass from side to side like strings; and it is the rush of air over these that gives rise to our voice. There are muscles connected with these cords which tighten or relax them, and thus produce different tones.

The tongue, the lips, the cheeks, and the palate, assist in modulating or shaping the sounds which proceed from the parts above named. By these means we articulate, or speak, that is, express ourselves in words or language. Reason,

which our bountiful Maker has given to us, enables us to clothe all our ideas and varieties of thought and feelings in equally varied tones and language. Other animals have voice also, but the want of reason confines its use to the expression of their simplest wants.

During a severe cold, when the vocal organs are inflamed and thickened, our voice is hoarse and indistinct; and if the parts are so much swollen as to prevent their usual action, our voice is almost lost, and we speak in a whisper.

The warmth of our bodies is a very wonderful circumstance. It is called animal heat, and depends on respiration. By this we preserve nearly the same temperature, whatever may be the nature of the climate around us. This provision is confined to the Animal Kingdom.

If we examine a mineral, or a vegetable, we shall always find it just of the same heat as the air, whilst our own body never varies more than three or four degrees from 98° of the thermometer; and this, whether we are surrounded by an atmosphere many degrees below the freezing point, or by one nearly as hot as boiling water.

Now this is a very remarkable fact, and shows how wonderfully we are constituted, thus to resist the influence of changes from heat to cold which must have proved fatal to us, or confined us to

a particular climate, or forced us to migrate at certain seasons. It is this, together with the power of accommodating ourselves by clothing of different kinds, and of living upon various kinds of food, that enables man to dwell in every part of the world.

He, indeed, who should form his opinion of the origin of men on the mere contrast that he finds between the negro of Africa, the fair European, or the Esquimaux of the Polar regions, might imagine that there had been divers creations of men, and various parent stocks; but he who refers for the origin of men to the Holy Book that contains the revelation of Almighty God, acknowledges one man created first, from whom all other men have descended, by a lineage that is traced not with much difficulty; and in every variety which has come of one man's blood, he finds fresh cause for admiration of the providence and power of God.

QUESTIONS.

In what place are the organs of voice situated?
What produces sound?
How are different tones produced?
What enables us to speak?
Have other animals voice?
Is the voice of animals more limited than our own?
What happens to the voice when we have a cold?
How does our body differ from vegetables and minerals in warmth?
Does the heat of our body vary much under different temperatures?
At what degree of the thermometer is the heat of the body?
What advantages do we derive from this equal temperature in all situations?

LESSON XIII. *The Brain; the Spinal Marrow; Origin of Nerves; Superiority of Man.*

ALMIGHTY God, in making our bodies, has carefully protected those parts which are most important to our well-being. Thus the heart and the lungs are covered and shielded by the ribs, breast-bone, and spine; and the stomach is placed amidst soft and yielding parts, that it may give way to blows or fulness. It is, however, in those organs which are the seat of mind, and which make us intelligent and sensible creatures, that wisdom and care are most conspicuous.

The brain is at once the most important and most delicate portion of our system; and to guard it from injury, it is shut up in a bony case consisting of many pieces curiously fastened together, strengthened by ridges of bone; and of an arched form, of all others the best adapted to sustain pressure.

The skull, in which the brain is contained, is not only thus fortified, but its cavity is divided by strong webs, on which the different parts of the brain are supported. No accident of any ordinary kind can reach it, and nothing but falls from considerable heights, or heavy blows with some hard instrument, can break through its

walls. Were it otherwise, we should be liable to injuries from numerous causes, which would either destroy us, or make us miserable for the rest of our lives.

The substance of the brain is soft and white, and is arranged in a most curious manner. It is divided into two portions; one occupying the front and upper part of the head, and called the *cerebrum*, or proper brain; and the other, the lower and back part, and called the *cerebellum*, or little brain.

It is more copiously supplied with blood than any other part of our body, for though it seldom weighs more than three pounds, one sixth of all the blood passes through it. From its lower surface branch off in regular pairs many of those white cords or nerves, which we have mentioned as running in all directions through the body.

The nerves which supply the organs of all our senses, except that of touch, arise in the brain, and have been divided into nine pairs, usually distinguished as the *first pair*, &c., the offices of which are as follows—

The *first pair*, or olfactory nerves, are distributed over the whole interior of the nose, and form the organ of smell.

The *second pair*, or optic nerves, enter the eyes, and form the retina, or seat of vision.

The *third* and *fourth pairs* are very small, and are distributed over the muscles of the eye.

The *fifth pair*, the largest of the series, is divided into three branches on each side. The first branch extends over the forehead, upper eyelid, and the nostril, and also enters the eye-ball; the second branch is found in the upper jaw and the palate; and the third branch supplies the nerves of the muscles and glands of the lower jaw.

The *sixth pair* chiefly supplies one of the muscles of the eye-ball; but the *seventh pair* is composed of two portions, one of which forms a kind of nervous labyrinth, which lines the internal ear, and the other sends branches to the muscles of the ear, and the adjoining glands and parts of the face.

The *eighth pair*, after supplying the back part of the throat and the root of the tongue, descends the neck, and having joined the great sympathetic nerve is distributed over the substance of the heart.

The *ninth pair* principally supplies the tongue and its muscles.

The *great sympathetic nerve* is formed by the union of parts of the fifth, sixth, and eighth pairs, with some of the nerves of the neck, and running down by the spine, it spreads itself over

the cavities of the chest and the abdomen, and their contained organs, thus connecting them with the brain. It is by means of this nerve that any disturbance of the stomach also affects the head, and from this circumstance it is that the nerve has received its name of the great sympathetic.

The spinal marrow is a continuation of the substance of the brain proceeding down the back-bone, which forms a hollow column, made up of twenty-four separate bones, strongly bound together by cartilage, ligaments, and muscles, within which the spinal marrow is safely lodged. As it proceeds downwards, a pair of nerves arises at every bone, one of them going to the right, and one to the left, and six or seven pairs more arise from the large bone at the bottom of the spine. These supply the various parts of the body as they branch and ramify in every direction.

When any portion of the brain, or spinal marrow, is impressed upon or injured, the function or office of the nerves which proceed from it is destroyed, and the parts they supply lose motion and feeling. It is to these organs, therefore, that we owe all our sensations or feelings.

The brain is also the seat of the mind, or of our intellectual faculties; it has been called "the

palace of the soul;" and if it be oppressed or diseased, we lose our consciousness, or sense of being. Were it not for this organ, we should not be sensible of any of the beauties of nature; and the whole world would be a blank. We should know nothing of the light of day, the warmth of the sun, the beauty of the night; nor would any of the sweet sounds which now delight us ever meet the ear.

Many parts of the animal creation appear to be destitute of brain, and in none is the size of the brain in any uniform proportions to the bulk of the animal. The brain of the elephant is small compared with the vast size of the body; and the brain of a whale, ninety feet long, and weighing eleven thousand pounds, is not much larger than that of a man. In short, in none is the brain so perfectly made as in mankind. Our sphere of enjoyment is therefore much greater than that possessed by any other animal. Let us be grateful to our Creator, who has thus placed us the highest of His creatures,—who has given us power to know and to admire the "wonderful works" of His hands; and let us apply all our varied endowments to their right purposes, namely, to be good and useful members of society, and to love God "with all our soul and with all our strength."

QUESTIONS.

What is remarkable in our most important organs?
How is the brain protected from injury?
What appearance has the substance of the brain?
What is its usual weight?
Is there anything remarkable in its circulation?
What nerves arise in the brain?
Mention their names and uses.
What is the spinal marrow?
How is it defended?
In what way does it give off nerves?
What happens when a portion of the brain or spinal marrow is injured?
Are our mental faculties affected by injuries of the brain?
What important services do we derive from this organ?
Is the weight of the brain proportioned to the bulk of the animal?
Has any other animal a brain as perfect as man?
What is the lesson to be gathered from these considerations?

LESSON XIV. *The Senses; the Organs of the Senses; Touch.*

IT is by means of our senses that we become acquainted with the qualities of the objects which surround us.

The senses are five in number—namely: Sight—Smell—Taste—Touch—and Hearing; each of which conveys feelings of a different kind to the brain.

These different impressions assist us in forming an accurate idea of the nature of any body which we examine. For instance;—we *see* an apple, its colour is green; and its form appears spherical; we *touch* it, and find that it is a hard smooth body; we *smell* it, it has a slight but

agreeable odour; we *taste* it, and discover that it has a grateful sub-acid flavour; thus four of our senses are called into play, in order to acquire an accurate knowledge of the properties of a single body.

Let us consider a moment how imperfect our knowledge would be, and how much gratification would be lost to us, if any one of these conditions were wanting. It is, indeed, from the use of our senses that we obtain most of our pleasurable emotions; the summer evening's ramble, and the snug and comfortable winter parlour, would alike be deprived of their charms, were our senses denied to us, or imperfect.

All the sights and sounds that fill the world with beauty and harmony are conveyed to us by their means; nor can we sufficiently admire the goodness which has so wonderfully provided them as things of necessity, and which has, at the same time, made them the sources of so much pleasure and instruction.

Four of our senses, as we have seen, are confined to small spaces, but that of *touch* or *feeling* is extended over the whole body, though it is more acute in some parts than in others. The hands, and especially the fingers, have a most delicate and nice sense of touch. In these the skin is thin and plentifully furnished with nerves.

Habit will, however, render these nerves almost insensible; blacksmiths and others, who are always handling hard substances, and lifting heavy hammers, can bear even fire for a short time without feeling it. This want of feeling is owing to the epidermis, or scarf skin, becoming thick and horny, and thus preventing impressions being received by the nerves.

The sense of touch enables us to know whether bodies are hard or soft, solid or fluid, rough or smooth, hot or cold. As the knowledge it conveys is the most accurate, it is generally called in to assist the other senses; and when we are deprived of some of these, by a wonderful dispensation of Providence, it in a great measure supplies their place. Thus, *touch* alone enables the blind man to learn many useful arts, which we cannot acquire without using our eyes.

QUESTIONS.

What do we learn by our senses?
What number of senses have we, and what are their names?
Can you tell in which way four of them assist in finding out the qualities of an apple?
Are our senses the means of conveying many agreeable feelings to us?
By what means are impressions conveyed to the brain?
Which of our senses are confined to small spaces of our bodies?
Do all parts of our bodies feel?
In what part is the sense of touch most perfect?
How do the hands of hard-working people get insensible?
What do we distinguish by the sense of touch?
Which of our senses gives us the most accurate impressions?

Lesson XV. *The Tongue; the Nose; the Ear.*

The *tongue* is the principal agent in tasting. It is full of vessels and nerves; so that it possesses a greater portion of vital energy than any other part of the body. It can be moved about freely in all directions, and made broad, narrow, or slightly hollow, at pleasure.

If you pass the finger over the surface of your tongue, you find that it is rough. This is owing to a multitude of little points, called *papillæ*; which are very sensitive, and erect themselves when we are tasting. It is in these little points that the nerves end, and it is in them that the sense of taste immediately resides.

The flavour of what we eat is very various. Some things are agreeable, others disagreeable; but taste, like the other senses, soon reconciles itself to almost anything, however unpleasant it may be at first. The *gustatory*, or tasting nerve, is fitted to convey these different flavours to the brain; but to do this it is necessary that they should be in a liquid state, and in order to render them so, the mouth, whenever we are eating, is furnished with saliva, by glands in each jaw.

Smelling is closely connected with tasting:

and the organs of taste and smell, namely, the mouth and the nose, open freely into each other.

Most bodies emit a smell:—that is, they give out *odorous* particles. These, floating in the air, are drawn into the nose, and are there made sensible to us, by means of the *olfactory*, or smelling, nerve.

The structure of the nose is very curious, and most beautifully adapted for its purposes. The nose is a large cavity formed of bones and gristle, opening in front by the nostrils. These are directed downwards, in order to receive smells, which gradually ascend; and behind are two wide apertures which lead into the back of the mouth.

The whole inner surface of the nose is lined by a soft and delicate membrane, called the *pituitary membrane*, in the substance of which the nerve of smelling is spread out. This membrane is abundantly supplied with blood, and it is in consequence of this, and the softness of its texture, that we are liable to bleedings from the nose.

The senses of smell and taste convey many powerful and delightful sensations, and are of the highest utility in guiding us in the selection of our food. The effluvium, or smell, proceeding from substances in general affords a correct

way of judging as to their wholesomeness or unwholesomeness, and we are naturally led to smell anything new to us before we venture to taste it.

The ear is a most complex and beautiful organ. It is the most perfect *acoustic*, or hearing instrument, with which we are acquainted, and the ingenuity and skill of man would be in vain exercised in the attempt to imitate it.

By the ear we are made sensible of *sound*. If a glass, or any other sonorous body, be struck, it *vibrates*, and emits what we call sound. This sound spreads into the surrounding air, and is carried forwards, by a series of undulations, or waves, to a distance determined by its force or intensity, the direction of the wind, and the state of the atmosphere.

These undulations strike the ear, and give us the impression of sound. In order that this impression should be conveyed to the *sensorium*, or brain, the ear has been provided.

The outward ear is so constructed as to collect the sound, and retain it, so that it may not pass off, or be sent too rapidly through the opening into the tube of the ear, where it strikes the *drum*. This is a circular membrane stretched across the passage leading to the internal ear, and is also called the intermediate

ear. This drum vibrates, as would the parchment of a drum-head; and it gives the same vibration to a chain of several little bones connected with it; and these carry the sound onward to a winding passage filled with fluid, and called the internal ear, possessing all the known varieties of apparatus, which are only partially present in other classes of the creation.

The whole surface of this part of the human ear is lined by the filaments, or twigs of the *auditory*, or hearing, nerve, and this is the immediate seat of the impressions conveyed to us by the sense of hearing. These impressions are very varied in their character, and excite equally varied emotions in the mind; from the rush of the summer breeze through the dancing leaves, to the peal of the thunder-storm, and the softest breathing of distant music.

QUESTIONS.

What is the principal agent in tasting?

Can the tongue be moved in all directions, and its shape varied?

What is the surface of the tongue covered with?

Does the sense of taste reside in the papillæ?

Is it necessary that bodies should be dissolved to enable us to taste them?

What do we mean when we say that objects have a smell?

How does smell enter the nose?

In what membrane does the nerve of smell expand itself?

Why is it that we are liable to bleedings from the nose?

What is sound, and how is it conveyed to the ear?

In what respect does the ear of man differ from that of other classes of the creation?

Can you give any account of the means by which sound passes to the nerve of hearing?

Lesson XVI. *The Eye; Vision.*

When we look at the eye, we see that the front part of it is bright and transparent, and that behind this there is a dark-looking curtain, with an opening in its centre. The bright part is the *cornea*, and is fixed into what we call the *white of the eye*, very much in the same way that a watch-glass is fixed into its case. The curtain is named the *iris*, and the opening through it, the *pupil*.

The iris is a very delicate circular muscle, and its colour is owing to a dark paint which covers it behind, and which easily washes off. The action of the iris is seen if we bring a candle close to the eye; the pupil contracts closer and closer, according to the brightness of the light, and enlarges again as it is removed. In order that its action may be perfectly free, the part in which the iris moves is filled with a watery fluid, called the *aqueous humour*.

Further back, in the ball of the eye, are other curious parts, as the *crystalline lens*, which is in shape just like a small glass in a telescope, and is placed exactly behind the pupil; and a third humour called the *vitreous humour*.

All these parts are made to conduct and gather the rays of light. They are subservient to

another part called the *retina*, which is the expansion of the *optic*, or seeing nerve. This nerve passes through the coats of the eye, and immediately divides itself into a half-circular net-work, covering and lining the whole of the inner surface of its back part. It is by means of the retina that we receive impressions of light, and *see* the objects around us.

The ball of the eye is of a roundish shape, and furnished with six muscles, by means of which it can be turned in every direction.

This delicate and curious organ, the eye, is very carefully protected. It is placed in a bony cavity called the orbit, and provided with two moveable outside curtains, known under the name of eyelids. These guard it from dust, keep the front bright and clear, and spread the tears over the whole surface of the eyeball, so that it may be always moist, and easily moveable. In these offices the eyelids are assisted by the eyelashes and the eyebrows.

The retina is perhaps the most delicately sensible membrane of the animal frame. It is readily affected by the rays of light, which, when too intense, excite very painful sensations; but, to prevent this, the eye is furnished with lids and lashes.

To enable us to close our eyes when we go to

sleep, or when we are pained by an excess of light, the lids are provided with muscles, and can perform very rapid motions.

Let us now consider how admirably our eyes are fitted for vision. It is light which renders objects visible to us, for we cannot see in a dark room, or in a very dark night. Now, what we call light, is a succession of rays proceeding from any luminous body, which rays, after striking upon objects, are reflected, or thrown back. When we see an object, therefore, it is because these reflected rays enter our eyes, and fall upon the retina. In this way a perfect picture is formed at the bottom of the eye, just as we see our face reflected in a looking-glass.

In order, however, that the image or picture may be formed upon the retina, it is needful that the rays of light should pass through the eye. For this purpose the cornea and parts behind are transparent, and permit the rays to pass freely; whilst the crystalline lens refracts or bends them, so that they proceed in a proper form and direction.

During this operation, the iris contracts or expands, to regulate the quantity of rays which the retina can bear. By this beautiful and simple contrivance, the eye accommodates itself to the different degrees of light to which it is exposed.

It is a bad practice to look for a long time at a strong light, as this weakens the iris, blunts the sensibility of the retina, and consequently injures the sight.

It is wonderful to reflect how perfect an instrument is the eye. Thus in looking at a landscape of hill, dale, and plain, even of many miles in extent, the whole space, with its numberless objects of all colours and sizes, is represented on the bottom of the eye; and though the picture is not half an inch in diameter, how accurate it is, and how minute in all its details, not a line or a shade being omitted! It has been called the great inlet of man's knowledge; and a celebrated writer has said that "the opening of the eye is to the human countenance what light is to the natural landscape."

QUESTIONS.

What do we see when we look at the front of the eye?
What is the iris, and what is the opening through it called?
How may we observe the action of the iris?
What provision is made that it may move freely?
What is the retina, and where is it placed?
Can you tell what part of the eye makes us sensible of light, and enables us to see?
How is the eye protected?
Can you name the uses of the eyelids and eyelashes?
What is light, and how do we see an object?
Can you tell what is needful in order that a picture be formed on the retina?
How does the eye accommodate itself to different degrees of light?
Mention one proof of the wonderful perfection of our eyes?
What has the human eye been called?

Lesson XVII. *Changes of the Human Body; Infancy; Childhood; Youth; Manhood; and Old Age.*

The changes that take place in our bodies, as we advance from infancy to old age, are not less curious than instructive. The hand of our Almighty and all-wise Creator is visibly at work upon us, and we find that, in every period of life, our organs and their actions are wonderfully fitted to our wants and conditions.

Man is, in himself, a defenceless, helpless, creature. No other animal continues so long in a state of infancy; no other is so long before it obtains its teeth; no other is so long before it can stand; and no other arrives so late at maturity.

What helpless little creatures we are in the earlier periods of our life, and how totally we are dependent upon the care of others! An *infant* cannot, for some months, even direct its eyes to any particular point, or carry its hand to its mouth. Its bones are soft, and if it were allowed to support itself, its limbs would bend beneath its own weight. A great part of its time is passed in sleep, or in satisfying its mere animal wants, and beyond these its feelings seem very

limited. Digestion and nutrition are, however, very active, and the infant grows rapidly.

A few short years, and what different beings we become! We can talk, run, leap, feed ourselves, and from morning till night are never still. We are now *children;* our bones are harder, our muscles stronger, and our senses more perfect. We eat frequently; because our bodies are fast increasing, and our digestion is active. We have teeth, and our diet is no longer milk and pulpy matter, but consists of various articles, as bread, butter, cheese, fruit, and animal food. We now begin to exercise the mind; we are taught the names of objects, how to distinguish what is right from what is wrong, and we learn how to be good and obedient. We still, however, require the constant care of our parents, and ought never to be long out of their sight, lest our ignorance and thoughtlessness should lead us into danger.

Again, a few years pass over us, and we arrive at *youth.* We are now no longer confined to the nursery, nor do we need constant care, for we have learnt how to protect ourselves, and know what to avoid. Our bodies are now strong and vigorous. Our bones are almost completely hardened, and our muscles capable of powerful exertion. We can carry heavy weights, and go

through a great deal of labour or of active sport. We are sent from home to acquire knowledge, for during this part of our lives the mind is active and inquisitive, and it is our duty to store it with useful information, so as to fit us for performing our public and private duties. We now begin to mix with our seniors, and occasionally to enter into conversation with them, as we can think, compare, and recollect. Our growth is still going on, but less actively than before, and most of our organs and functions are perfect.

Again a few brief years, and we are *men*, mixing in the world, and probably removed from our paternal roof. The body is full grown and vigorous; the complexion darker; the voice deeper and more powerful; the muscles larger and firmer; the bones increased in thickness; and the mental faculties quite mature. We can now exercise our own freewill, are masters of our own actions, and in most cases dependent on our own exertions for support. Our character becomes more grave; and from the constant occasion we have for exercising the judgment, we think more, and lose our fondness for many of those active exercises which delighted us in earlier life.

But a short time, and another change comes

over us. We become *old*—we lose the firm step and determined purpose of manhood; the buoyancy and intelligence of youth; the hilarity and sportiveness of childhood; and the quiet unconsciousness of infancy. The body shrivels, and its outlines become angular; the teeth fall out; the eyes are dim; and the hearing, touch, and taste, imperfect. We reach the verge of life; and, after tottering for a while upon its brink, we sink into the grave. "There the wicked cease from troubling; and there the weary be at rest. There the prisoners rest together; they hear not the voice of the oppressor. The small and great are there; and the servant is free from his master."

QUESTIONS.

Can an infant direct its eyes, and carry its hand to its mouth?
In what state are its bones?
How does it pass the greatest part of its time?
Can you mention some of the respects in which we are changed from childhood?
What do we learn at this period of our lives?
When do our bones become hard, and our muscles capable of great exertion?
Are our minds active and inquisitive in youth?
What should we be careful to do at this time?
When are our bodies full grown?
Are our complexion and voice changed in manhood?
Why do we no longer delight in bodily exercises?
What happens to us when we become old?

LESSON XVIII. *Differences in the Form of Mankind, and the Inferior Animals.*

MAN has faculties and powers which raise him in the scale of creation far above every other living thing with which we are acquainted. To man we may apply the words of the Psalmist, and say, "Thou madest him to have DOMINION over the works of thy hand."

It has been shown how wonderful his structure is, and we will now point out a few of the most striking differences which exist between man and other animals.

The structure of the teeth, and the form and size of the intestines, in man, differ considerably from those of the inferior animals. These are so constructed as to be fitted for the kinds of food which are taken by human beings.

The human teeth have the enamel all on the outside; but in such animals as graze or feed on vegetable matter, the top of the teeth is broad and uneven, and has ridges of enamel mixed with the bone. This enables them to grind their food; for the softer bone wears away, and leaves the teeth very irregular, in consequence of the greater hardness of the enamel.

The stomach and intestines of these *graminivorous*, or grass-eating animals, also differ from

ours. Those which chew the cud, as the cow, for instance, have more than one stomach, and they can return their food into the mouth to be still further masticated. Their intestines are also very long, much longer than our own.

Such animals as are *carnivorous*, or flesh-eating, have a structure just the reverse: their teeth are large, sharp, and pointed: their stomach is small and simple; and their intestines are very short.

The teeth and intestines of man are in form and size between these two; we have neither rough grinding teeth, and a double stomach like the cow, nor fangs and short intestines like the lion.

The cause of this difference is obvious. Vegetable food is much less nutritious than animal food, and a longer time is required to extract the nourishing juices from it. The cow, therefore, grinds it twice over, and the food has to pass through a canal of great length. In the lion, the food is much more nourishing and easier of digestion. Hence its teeth are made to tear, and pull the food into pieces; its stomach is small and simple, and the canal short.

In man, the teeth are set even in the jaws, and are fitted both for biting and grinding, though he cannot tear his food like the lion, or reduce it into

so complete a pulp as the cow. His stomach is of moderate size, and his intestines of a medium length. By these means he is enabled to eat and to digest both animal and vegetable substances; and for this reason man is called *omnivorous.*

Man alone has the front teeth in the lower jaw standing in an upright direction; in all other creatures they slope backwards; hence man is the only animal which has a proper chin.

Quadrupeds whose heads are heavy and hang down, are provided with a very strong ligament, popularly called pack-wax, at the back of the neck, to hold the head up. We have nothing of the sort, as our head is placed on the top of the spine, and needs no such support.

If we watch horses or cows on a warm day, when the flies are troublesome, we shall see that they have the power of wrinkling and contracting the skin, so as to dislodge anything which settles upon it. This is owing to a thin muscular layer, stretched beneath the skin. We have nothing of the sort, as our hands can reach all parts of our bodies; consequently, we do not want it.

QUESTIONS.

Do our teeth differ from those of grazing animals?
What animals have longer intestines than man?
What kind of teeth and stomachs have carnivorous animals?
Why is man called omnivorous?
How is the head of a quadruped sustained?
By what means do animals free their skins from insects?

LESSON XIX. *Of the Instinct of Man a. Animals; Reason.*

ANIMALS are guided in supplying their wants, rearing their young, and in protecting th selves from danger, by instinct. If grass be gi to a dog, and flesh to a cow, neither will t touched by those animals. This is the result of instinct. The structure, indeed, of the digestive organs in animals is fitted only for that one kind of food which they always take when in a state of nature.

In judging of the habits of animals, we should remember that we are liable to be deceived if we consider those only which are domesticated. The taste of domesticated animals becomes to some extent changed; and this is the reason why their health is inferior to that of wild creatures, and why they are liable to many diseases.

By instinct, we understand a propensity and a power for performing certain actions which are necessary for our preservation. Instinct has been given to us by our Almighty Father in order that such actions may be performed at once, and without the aid of our slower process of reasoning,—for we, as well as animals, have instinctive actions.

Thus, when we are in danger, we either fly from

so or defend ourselves as we best can, with c arcely any knowledge of what we are doing. le, for example, we have the misfortune to fall t(o water, and cannot swim, the mere instinct ... self-preservation often enables us to escape wning; though we can give no account, or at a very confused one, of the means we took to effect this.

As it is essential to our well-being and existence that we should be nourished and refreshed by food and drink, what we call hunger and thirst are instinctive wants, and are quite independent of our will.

This is a wise and merciful arrangement of Providence; for did the supply of our necessities depend solely upon our own wishes, how often should we neglect them! and thus derange the system, or perhaps even destroy health. In grief, in the hurry of business, in study, and on other occasions when the attention is engrossed, did not hunger and thirst remind us of what was going on within us, we should abstain from food till our strength was exhausted.

Thus man and animals are equally possessed of instinct. In addition to this, however, man has reason—the noblest of all his attributes, and which has not been given to the brute creation.

The importance of reason or understanding

may be seen by noting our own actions—when, for instance, we meet with some new object, as a stone or a plant. We look at it, and examine it; we know nothing about it; it is quite new to us. Reason is now called in to assist us; we wish to acquire a knowledge of the object, we begin to think about it, and we endeavour to find out what it is.

First, then, we consider whether we have ever seen anything resembling it; this is an exercise of *memory:* then we *compare* it with surrounding objects; we then *taste* it, or *smell* it, and *feel* it, and thus acquire a knowledge of its sensible qualities. We now know a great deal about it, and begin to *reflect* upon what its nature and uses may be. We *judge* that it is fit or unfit for food, that it has or has not the same properties as some known body, and finally, we satisfy ourselves upon all points connected with it. This done, we seldom forget it. We know something that we were ignorant of before, and thus by a continued course of observation we go on acquiring knowledge.

We see nothing like this amongst other animals. The most beautiful objects seem to be passed over by them with indifference, and attention is only paid by them to the supply of their simplest wants.

Man stands alone in his pre-eminence of intellect, and well might the greatest of uninspired poets exclaim :—" What a piece of work is man! how noble in reason! how infinite in faculties! in form and moving how express and admirable! in action how like an angel! in apprehension how like a god! the beauty of the world! the paragon of animals!"

QUESTIONS.

Why is grass refused by a dog, and flesh by a cow?
Why should we be cautious in judging of the habits of animals from those of domesticated ones?
What do we understand by instinct?
For what purpose has instinct been given to us?
Are we always conscious of the means by which we escape from danger?
What are hunger and thirst?
What might happen did not instinct govern these?
Is instinct common to man and animals?
What has man beyond instinct, which brutes have not?
Endeavour to describe the mode in which our reason operates when we find any new object.
How do we acquire knowledge?
Is anything like this discoverable amongst animals?

LESSON XX. *The Beauty and Perfection of Body and Mind: Health.*

THE human form is beautiful and graceful. The limbs are straight and full of symmetry,—the countenance pleasing and expressive,—the motions active and powerful. Much of this, however, depends upon the care taken of children during their earliest years; for awkward habits

are very soon acquired, and their bodily strength is impaired, by negligence in apparently trifling matters.

Children should be early taught to hold the body erect, whether sitting, standing, or walking; and they should not be permitted to lounge with the head hanging down, or the shoulders brought forwards. They should be encouraged to take light exercises suited to their strength, and tending to make the limbs agile and supple, and prepare them for labour. Nothing is worse than to sit moping, and without the attention directed to some object. If we do so we lose our liveliness and spirits, become dull and inactive, and never possess that charm which cheerfulness gives to ourselves and to others.

But beauty does not consist alone in bodily perfections. It is in vain that children or grown persons are handsome or well shaped, if their mind and disposition be not properly cultivated. Their passions and tempers require particular care. A quarrelsome, revengeful, or obstinate child, is constantly doing some wickedness, and making himself and his friends unhappy. His countenance is deprived of the delightful expression which happy children derive from conscious innocence, and reflects only the bad thoughts which fill his heart.

In early life, also, it is most important that we attend to the instructions which are given to us; for our minds are then peculiarly suited to receive instruction. If we suffer the season of youth to pass away in idleness and indifference, we shall never cease to regret it; because, in after-life, we shall neither have time nor inclination to atone for our folly.

However perfect the body or mind may be, we are useless to ourselves and to others without health. This is, indeed, a great blessing; for without it neither riches nor wisdom can avail us. How needful is it, therefore, that we should take every means to procure health, and every care to preserve it!

We are in good health when we relish our food, and feel no uneasiness; when we have the free use of our limbs, when our senses are perfect, when our mind is unclouded, when our sleep is sound and undisturbed, and when we can bear the changes in the weather: in other words, we enjoy good health when all the functions of our body are performed in their proper order, and without conveying any disagreeable sensations.

Much of their future health depends upon the treatment children receive till they are ten years of age. If during that time they are allowed to eat improper food, are shut up in a close and

unwholesome atmosphere, and are suffered to neglect cleanliness in their persons, the seeds of many diseases are sown in the system, from which they may probably never be able to free themselves.

To maintain our body in health many points must be attended to. It must be nourished by proper food, protected by fit clothing, exercised by labour, refreshed by rest, kept perfectly clean, and preserved from outward injuries; respiration must be carried on in pure air, and the passions must be properly regulated. This latter point is, indeed, of the very first importance; for, however favoured we may be in other respects, a failure in this renders useless all the rest.

QUESTIONS.

What is observable in our general form?

At what period of our lives should we be carefully attended to?

Can you tell what should be taught us in childhood, and what kind of exercise we should be encouraged to take?

What happens if we pass our time in idleness?

By what means shall we make ourselves and friends unhappy?

To what should we be attentive in early life?

What must happen if we are not attentive?

What is the greatest blessing we can enjoy?

When are we in good health?

By what means may our health be ruined when we are children?

Are we liable to many diseases at this period?

Can you repeat by what means our health may be preserved?

LESSON XXI. *Of Eating and Drinking; Food and Drinks.*

WE eat and drink in order to appease our hunger and thirst, and to supply the waste going on in our bodies. Young people generally eat more than old people, because they are growing, and their digestion is rapid. The principal articles of our diet are, bread, garden vegetables, fruit, milk, and animal food, such as fish, fowl, beef, mutton, veal, and pork.

We live best on a mixed diet, neither confined to animal nor to vegetable food, nor to one particular kind of either. It is for this reason that our meals generally consist of different dishes. We should, however, be very careful not to mix too great a variety of different substances in our stomachs at one time.

Hunger is the best sauce, and the best cook. We may pamper our appetites with luxuries, but we shall never relish anything unless we come to it hungry; and if we are hungry the simplest fare becomes a luxury.

Labour, and exercise in the open air, are the best promoters of appetite; when we have taken these, we eat our meals with a relish, and they do us good. It is a grievous error, however, to suppose that eating a great deal is a proof of a

healthy appetite; or that by eating much we get more nourishment.

It is useless to eat more than the stomach can digest, and no stomach can digest food when it is over-loaded. The undigested food, therefore, has to be pushed into the bowels unprepared, and there it excites all sorts of mischief; hence, we see that great eaters are in general thin and pale, and of unhealthy appearance.

It is advisable that most part of our food, whether animal or vegetable, should undergo some preparation before it is taken into our stomach, that it may be softened, improved in flavour, and rendered more digestible. This process is called *cookery*. Vegetables are mostly boiled;—animal food is either roasted or boiled. Thus we see that cookery is necessary to health; but it has been observed by a clever physician, that, "Beyond a certain degree of roasting and boiling, the art of cookery is nothing but that of pleasing the palate at the expense of the stomach."

We should not, when we are in health, take food too often. The stomach is three or four hours in digesting a meal; and taking another before the previous meal is removed from it, interrupts its action, and deranges its functions.

Every meal should consist of a due mixture of solids and fluids. We should not eat largely

without drinking, and properly mixing the food with the saliva. We should, therefore, never eat hastily, but masticate what we take very well, and drink when we feel a desire so to do.

The best and most universally palatable drink is pure water. At meal times this is the most proper drink,—but there is no objection to weak table beer; children should never be allowed any stronger drink; and it would be much better for all, to abstain from wine and strong drinks. These stimulate the stomach too much, and in the end injure its tone, and impair the digestive organs.

It is dangerous to begin to drink wine and spirituous liquors early in life. God, who has given them to us, has no doubt designed them for our benefit; but no part of his gifts is more abused. They are not necessary for us in health; and it is wiser to avoid them, lest we be betrayed into that most odious of vices—*drunkenness.*

By drunkenness we are deprived of reason, and may be led to commit crimes almost unknowingly; and even if we escape crimes, to offend against decency and good manners. Besides, the constant or excessive use of spirituous drinks weakens the stomach, impairs the senses, and brings on dropsy, and other diseases.

We should moreover make it a rule never to

eat or drink anything very hot, because this spoils the teeth and injures the stomach. When we are much heated by exercise, and perspiring profusely, we ought never to drink cold water. Many accidents have happened from this imprudence, the stomach not being able to bear the shock.

QUESTIONS.

For what purpose do we eat and drink?
Why do young people eat more than old people?
What is the reason that our meals consist of different sorts of food?
How may the simplest fare be made a luxury?
What are the best promoters of appetite?
Is it well to eat a great deal?
What are the objects of cookery?
Why should we not take food oftener than every three or four hours?
What is the best drink?
Why should we not drink wine and strong drinks?
To what is their early use likely to lead?
Of what does drunkenness deprive us, and what may be the consequences?
Why should we abstain from very hot food or drink?

LESSON XXII. *Of Clothing.*

OUR dress should be made in such a manner, and of such materials, that we may feel neither uncomfortably hot, nor uncomfortably cold. It should, therefore, be suited to the season, and the particular habit of body or the state of health.

We should not allow what is called fashion

to interfere with this arrangement of clothing; for, if our system is delicate and our constitution naturally cold, it concerns our health and daily comfort, that we should be clad accordingly. At the same time, our dress ought always to be neat, as nothing can look worse, than slovenly apparel on a young person.

It is advisable to be accustomed from childhood to a light and cool dress, and to be inured to cold. Nothing is, indeed, more hurtful than to be muffled up and buried in a heap of clothes, so that we cannot stir or take any proper exercise, without becoming over-heated, whilst the perspiration is pent up, and does not evaporate. Thus, our clothes are made damp and uncomfortable, and we are liable to take cold the moment we get into a draught of air.

We generally err, however, in wearing too light a dress in summer. We should bear in mind, that the heat of the weather relaxes the skin, opens the pores, and increases the action of the heart. We, therefore, almost constantly feel hot, and are perspiring; and we throw the windows open, or seek the coolest places we can find. It is thus that so many colds are caught; as the perspiration is suddenly checked, and produces fever, and slight inflammation of the air passages. An eminent surgeon recommends that

boys should always wear flannel, to guard against the damp produced by exercise. He says, "It is no argument against this, that many boys thrive without it; the question is, whether a larger proportion would not escape illness by pursuing it."

Never wear any part of your dress so tight, as to press upon the body. All that is required, is that your clothes fit comfortably; and if they pinch you, or constrain your motions, they are sure to do mischief.

The best dress for a boy, is a round short jacket, made of strong woollen cloth, a waistcoat of the same, and quite easy, a pair of wide trowsers, buttoning to the waistcoat—in winter of good kerseymere, and in summer of some thinner woollen cloth; light woollen stockings, and shoes made sufficiently wide.

Boots which lace up the leg not only interrupt the circulation, but keep the feet hot and damp. Narrow-pointed shoes are also very improper, as they cramp and contract the toes, and prevent that freedom of action in them, which was intended to assist us in walking.

The feet should always be sufficiently clad, and preserved from wet. Colds are often taken by want of proper care in this respect; and it is a maxim, that to preserve health, we must keep

"the feet warm by exercise, and the head cool by temperance."

Thick fur caps are rarely advisable as coverings for the head; they over-heat it, and often give rise to scald-head and tender eyes. Amongst children, too, the neck should be left nearly bare, and everything in the shape of handkerchief avoided.

There is no part of our conduct in which we exhibit more absurd caprice, than in our clothing. Taste or fashion is permitted to lead us into ridiculous and unbecoming dress, and not unfrequently we thus sacrifice our health.

Tight stays destroy the health of many girls. They interfere with the free action of the lungs, by pressing upon the ribs; and with the business of the stomach, by forcing it from its natural place; indigestion and consumption are oftentimes the consequences.

QUESTIONS.

How, and of what materials, should our dress be made?

Should our clothing be varied according to circumstances?

What kind of dress is it best to be used to?

Why are a heap of clothes hurtful to us?

What should we be careful about in our summer dress, and why?

To what particular in fitting should we always attend?

Can you tell why lace-boots and pointed shoes are improper?

Why should we be careful in keeping our feet dry?

What mischief may arise from wearing fur caps?

What injuries are produced by tight stays?

LESSON XXIII. *Of Exercise and Rest.*

HOWEVER good our health may be, exercise is absolutely essential to keeping it so. This should, if possible, be taken in the open air; and then it will exhilarate and refresh us—make us cheerful and lively—promote digestion—and procure us sound slumbers.

Labour, which is only exercise of a severer kind, is highly salutary to us. It makes the body strong and robust—gives it firmness and tone—and prolongs life, by warding off those ills which are the consequence of idleness.

Walking, running, leaping, riding, and performing manual labour, are all proper for us; and we ought to diversify our studies and pursuits, if sedentary, by devoting some part of every day to these exercises. We should, however, be careful not to continue them too long or too violently; as, by doing so, we exhaust our strength, and may injure our health.

Exercise is particularly advantageous in childhood. At that time of life our feelings prompt us to be always in motion; and this disposition should not be checked. We observe the same thing in the young of all animals; witness the playfulness of kittens, and the sportive actions of the colt. This is a wise ordination of Provi-

dence, and calculated to encourage the growth of all our organs. We are not then fit for anything like labour, our bodies not having attained sufficient strength for continued exertion.

We should generally avoid taking exercise immediately after a full meal. The stomach is then actively engaged in digestion, and violent motion disturbs its operations, and is very apt to produce nausea, or sickness.

It is necessary that some part of our time should be passed in sleep. Complete repose, and the absence of all usual stimulants, recruit and refresh the body and mind; and however languid and fatigued we may be, a night's sound sleep renovates our strength and spirits.

It is a bad practice to indulge in sleep during the day; if we feel drowsy after eating, the stomach is overloaded, and we should be careful to eat less. Young children, however, should sleep an hour or two about noon, because their activity tires them out before night.

Sleeping apartments should be large and lofty, and plenty of fresh air should be admitted. Bed-hangings should be excluded from the rooms of young people; as they confine the air, prevent it circulating freely above the bed, and render the apartment unwholesome.

A hair mattress is best to sleep upon, and

children should never be laid upon feather-beds, which, though very comfortable, are too warm and relaxing.

We should be very careful not to be loaded with bed-clothes, and above all things, never to sleep with the head buried under them: on the contrary, the head, neck, and upper part of the chest, should rest on the pillow, and always be exposed.

The habit of lying in bed late in the morning is very prejudicial to health. Not only do we lose the "sweet hour of prime," the most delightful part of the day, but we waste a great portion of our lives in sheer indolence. Grown people do not require more than eight hours' rest, out of the twenty-four. Young children, however, should go to bed at seven o'clock in the evening, and be allowed to remain till the same hour in the morning. With weakly children, it is important to bear in mind that they are exhausted rather than refreshed by many hours' sleep. They should rise early, and if more sleep is necessary for their strength, they should be allowed to lie down and take repose for a short period during the day. It should also be remembered that children should never be wakened suddenly, as their nervous system may receive a shock from the slightest causes.

QUESTIONS.

What benefits do we derive from exercise taken in the open air?
What are the advantages of labour?
Name the kinds of exercise that are proper for us?
What is the disposition of children as to exercise?
Is the same thing to be observed in the young of animals?
When should we not take exercise?
What are the effects of sleep?
Why are bed-hangings objectionable?
What is best to sleep upon?
What parts of our bodies should be always uncovered during sleep?
Tell what we lose by lying in bed in a morning.
What number of hours' sleep is sufficient for grown persons and children?
Should children be wakened suddenly?

LESSON XXIV. *Of Cleanliness in Person and Dress.*

IF we wish to enjoy good health, we must keep our persons, dress, and habitations clean. Numerous disorders arise from want of due attention to this point.

In the back streets of towns, which are seldom swept, and are badly paved, the inhabitants, if they do not attend to cleanliness, are often affected by contagious diseases. The skin, when it is allowed to be dirty, is liable to eruptions. If a child is regularly washed, its skin will be free from these appearances, and as soft as velvet.

To keep ourselves free from these dangerous

and unsightly affections, the use of soap and water is all that is necessary. Not only should the face, hands, and feet, but the whole body also, be very frequently washed, and bathing should be resorted to as often as possible.

All boys should be taught to swim; but no child should ever venture into the water except in the presence of a grown person.

When you bathe, plunge at once over-head, and keep constantly moving about. Never bathe just after violent exercise, and when you are overheated and perspiring; this is very dangerous, and may bring on cramp of the stomach or limbs.

If the health is delicate, it is safer to bathe in the sea than in rivers; but, as a general rule, we ought to be in good health when we go into the water. After bathing we should never sit or stand still; if we do so, we are apt to get chilly and cold: gentle exercise, as quiet walking, should, therefore, always follow.

Great care should be taken that the place we bathe in is free from sunken rocks and deep holes; as we may strike ourselves against the one, or stick fast in the other. We ought, therefore, never to venture into an unknown place; many boys have lost their lives from such causes.

It is not enough that our skin is clean; unless our dress and habitations are free from filth, we cannot keep it so. Our linen and stockings should be frequently changed, and our dress at all times should be perfectly clean and neat.

The rooms in which we live should be washed, scoured, painted, and white-washed, from time to time, and there should be a free current of air through them.

Our bed-linen should also be clean, and often renewed; and the beds and mattresses beaten, and now and then taken into the open air.

QUESTIONS.

From what cause do many diseases arise?
Why are the poor liable to contagious disorders?
What part is very often diseased for want of cleanliness?
By what simple means may we preserve ourselves from many unsightly diseases?
What should all boys be taught?
Should a child ever go into the water alone?
Mention some of the things that should be attended to in bathing.
What should we be particularly attentive to in our dress?
What means should be taken to keep rooms clean and sweet?

LESSON XXV. *Of Pure Air.*

HEALTH is frequently injured by breathing impure air. Persons who are employed in preparing metals, especially lead and quicksilver, are generally pale and emaciated, and die young;

because the vapours which proceed from the substances on which they work are noxious, and by being drawn into their lungs, poison them by degrees. Painters are often afflicted with palsy of the arms, and dreadful attacks of cholic, from inhaling the effluvium of white lead when at their work.

How uncomfortable are our feelings when shut up in a close room with several other persons! We become hot, uneasy, drowsy, and unwilling to move, but if we escape from it, and get into the open air, what a delightful change takes place! We shake off our lethargy, are lively and animated, and wonderfully refreshed. How do you account for this? Because the air in the close room was exceedingly impure, and to some degree poisonous.

You have learnt that when we respire, the air undergoes a great change, is robbed of that portion which is essential to life, and its place supplied by another kind of air, which kills animals.

When several candles or lamps are burning in the room, the air is still more rapidly rendered unwholesome; because these bodies, in burning, also deprive it of its oxygen, or finest part. We can now easily explain why, in crowded evening parties, the company so soon get fatigued and

listless; and why people who are fond of them, are often ill, and appear pale and unhealthy.

If many children sleep together in the same room, the room ought to be spacious and freely ventilated: and it would be well if each child had a separate bed. But few families have room enough for this. There is no bed-room, however, in which the windows might not be often opened, or a ventilator fixed in them, that during the night the heated and foul air might escape.

Many contagious disorders are conveyed by means of the air. This should make us very cautious in going near places where sickness prevails; because, if we breathe an atmosphere loaded with *effluvia* from diseased bodies, we run a great risk of catching the disorder.

Rooms in which sick persons are confined soon become full of putrid exhalations or bad smells, and are very unhealthy, if shut up, and kept warm. This should be avoided, both on account of the patient and the attendants. A constant supply of fresh air is even more necessary during sickness than in health.

Low, damp, and confined apartments, are by no means to be chosen for dwelling-places, as it is impossible we should ever preserve our health in them. When deprived of the cheering influences of light and of cool fresh air, we droop,

become languid and depressed in spirits, and lose all enjoyment. Our appetite is gone; we do not relish our food; our sleep is disturbed; our whole frame shows signs of weakness.

Houses, to be healthy, should be built with airy rooms, and in dry situations, and not too closely surrounded by trees.

People who live in swampy districts, where vast quantities of vegetable matter are constantly decaying, are subject to *ague*, and other troublesome and dangerous disorders. This is owing to their breathing damp and impure air.

Neither men, nor animals, nor vegetables, can live, if the air which surrounds them be not constantly renewed. A plant, confined in a glass case, soon dies: and instances have been known where a number of men, shut up in a small close dungeon, have perished, after dreadful sufferings.

QUESTIONS.

Why do workmen employed on certain metals die young?
With what diseases are painters affected, and why?
How do we feel when shut up in a close room?
How do you account for this?
Why do candles and lamps make the air impure?
Is it well for several persons to sleep in the same room?
What means should be taken to keep the air pure in the night?
Why should we be cautious in going near places where sickness prevails?
What should be particularly attended to in sick rooms?
What happens to us if we have not light and fresh air?
In what situations should houses be built, in order to be healthy?
Why are the inhabitants of swampy districts subject to the ague?

LESSON XXVI. *Of the Preservation of Individual parts of our Bodies.*

As our comfort depends greatly on having our limbs and organs in a perfect state, we should be careful not to do anything which may injure them. If we are heedless in moving about, or in using cutting instruments, or without due caution approach machinery when in motion, we may fracture our limbs, inflict severe cuts upon them, or even be deprived of them. Any of these are serious misfortunes, and may be a source of torment and suffering through our after life.

The senses of hearing, smelling, and sight, are strengthened by exercise out of doors. We should not waste our time in the house, when the weather is fine, and we are not engaged in some necessary duty; because this confinement within doors makes the nose, eyes, ears, and skin tender, and likely to become sore when exposed to a fresh cool breeze.

The *Sight* is injured by a dazzling, unequal, and varying light. In reading we should never have the sun shining on the page, nor should we ever read by firelight; for not only is the light unequal and uncertain, but sitting near the fire overheats the eyes, and makes them painful.

Lamps which have shades to darken the room, and direct the light downwards, are not fit to read or work by; but lamps which have ground-glass shades shed a softened but clear light, which has no glare, and does not fatigue the sight.

The eyes require the greatest care. In the morning, in the afternoon, after exposure to sun or dust, or to the glare of snow, and at night, it is desirable to bathe the eyelids with water with the chill off, drying them gently with a soft towel. The eyelids should never be rubbed. After first using warm water, bathing the eyelids with very cold water is strengthening and salutary.

The *Hearing* is rendered dull by violent and sudden noises, and by an accumulation of wax in the ear. This should be carefully cleared away, as it gives rise to many uneasy feelings, and may even occasion permanent deafness.

The *Taste* is injured by the constant use of pungent food, and by indulging in spices. If these are persevered in, the tongue and palate are made insensible to anything less stimulating, and a simple diet becomes tasteless. Whatever injures the tone of the stomach, such as the immoderate use of wine and spirits, and high-seasoned food, injures the taste also.

The *Touch* is kept perfect by being exercised on a variety of objects; by the body being in a sound and healthy condition; and by strict attention to personal cleanliness.

When the hands and feet are stiff and benumbed with cold, we should never try to warm them by the fire, as this causes excruciating pain, and may do them harm. The best thing to restore the circulation in such case is to rub them together, to rub them with snow, or to plunge them into cold water.

The *Teeth* require particular attention. These are necessary to us for a variety of purposes; and if they become diseased, we are harassed by that distressing pain—tooth-ache.

It is in most instances through our own neglect that the teeth become unsightly, and fall away so early in life. We either disorder our stomachs by taking improper food, or we take our meat hot, and our drinks scalding—certain modes of destroying the teeth. By cracking nuts, or plum stones, or biting very hard substances, children often break their teeth.

The beautiful white substance with which the teeth are covered is called enamel, and is much harder than any bone in the body, but even this is cracked and destroyed by such foolish practices, and the nerves of the teeth becoming exposed,

we suffer acute pain, and are hardly able to enjoy our food.

Perfect cleanliness about the mouth should be diligently practised, not only for the sake of appearance, but as the best preservative from decay of the teeth. Every morning, and after meals, the teeth should be cleansed by a soft brush and pure water. A little *charcoal* now and then is all the tooth-powder requisite. Picking the teeth with pins is not only an offensive habit, but it is also exceedingly hurtful; since it loosens the teeth, and renders them more liable to decay.

When a tooth is so far decayed as to be useless, and is a source of frequent pain, it had better be pulled out. To endeavour to allay tooth-ache by hot applications is very pernicious; and the destruction of the rest of the teeth is often caused by such means.

QUESTIONS.

What kind of accidents are we liable to from carelessness?
What bad effect follows from confinement to the house?
By what kind of light are the eyes injured?
Why is fire-light unfit to read by?
Are shaded lamps proper to read or work by?
By what causes is the hearing rendered dull?
How is the sense of taste injured?
By what means is the touch kept perfect?
How should we warm our hands when benumbed by cold?
By what means do we spoil ou teeth?
Which is the best mode of keeping our teeth clean?
What is a bad habit, and should b carefully avoided?

Lesson XXVII. *The Temper and Passions: Advantages of Cheerfulness and Content.*

It is not enough for the preservation of health that our bodies are properly nourished,—that we are fitly clothed,—that we take exercise, and enjoy rest,—that we are cleanly in our persons, and live in open and airy situations. All these things are useless, if our temper and passions be not properly regulated.

It is useless to make a good meal of fit and nourishing diet, unless the mind is quiet and composed after it. A sally of passion, or a fit of sulkiness, spoils the digestion, and we had better have gone without food; because, not only does this prevent the food undergoing its usual changes, but it may lay the foundation of lingering disease.

But it is not after we have taken food alone, that passions and bad temper may injure us; we cannot even eat if we yield to them. We lose our appetite, the stomach gets disordered, and the most delicate meal is rejected. Unless the temper be serene and cheerful, we eat without an appetite; what we take we cannot digest; and food rather does us harm than good.

A happy-minded and amiable child is one of

the most beautiful and lovable of all God's creatures: the very sight of him has a tendency to soften our hearts, and to call into play our best affections: but God permits us all to be happy if we will seek happiness through Him.

Who that has been duly instructed in the way of true happiness, who that has but regard to his health and comfort, will indulge in bursts of violent passion, in fits of anger, or in sullenness? To do so is to commit the greatest folly of which we are capable. We can enjoy nothing when our hearts are filled with bad thoughts; because, as our internal feelings are bright or gloomy, so does everything around us appear.

If, then, we are cheerful and contented, all nature smiles with us:—the air seems more balmy, and the sky more clear, the meadows have a brighter green, the trees a richer foliage, and the flowers a more fragrant smell, the birds sing more sweetly, and the sun, moon, and stars, all appear more beautiful. We take our food with relish, and whatever it may be, we enjoy it. We feel better for it, stronger and livelier, and fitter for exertion.

Now if we are ill-tempered and discontented, there is nothing which pleases us. We quarrel with our food, with our dress, with our amusements, with our companions, and with ourselves.

Nothing comes right for us; the weather is either too hot or too cold, too dry or too damp. Neither sun, nor moon, nor stars, have any beauty; the fields are barren, the flowers scentless, and the birds silent. We move about, neither loving nor beloved.

Besides robbing ourselves of comfort and health, and becoming hateful to ourselves and to all around us, by passion and bad temper, we also unfit ourselves for performing our private and public duties. The passionate man—and the passionate child leads to the passionate man—is not fit to mingle in society. He is always making himself enemies, and giving pain to his friends and family. Nor is this all; every one who indulges in bad temper, and gives way to morose and sour feelings, sets a mischievous example to all around him, and spreads a baneful influence over the whole range of his connexions. The affections become weakened—confidence is destroyed—health is injured—nervous and painful diseases are created, and all comfort is banished from his dwelling.

To a man of this miserable disposition, the troubles which all must expect to meet in this life become so many sources of absolute torment! and all the common evils of life are changed into real misfortunes. Whilst the cheerful and thank-

ful man passes his days in such happiness as we are fitted to enjoy, the other is gloomy and dissatisfied, and makes his home cheerless. His countenance is clouded, and his gait sluggish; his body loses its healthy tone, and his mind is incapable of receiving those impressions from the external world which our bountiful Creator has sent to minister to our health and pleasure.

Always bear in mind, therefore, that if you would preserve health, you must be good-tempered; that if you would enjoy the beauties of nature, and the comforts of life, you must be good-tempered; that if you would be useful to yourself, and to others, you must be good-tempered; and that if you desire to show yourself worthy of the blessings which Almighty God showers down upon you, you must be content, good-tempered, and thankful.

QUESTIONS.

Why are our meals made useless to us by passion?
What may be the consequence?
What will deprive us of appetite?
In what way is a child's health and happiness to be preserved?
How is it that bad temper makes everything about us displeasing?
How may we enjoy all the beauties of creation, and make everything delightful around us?
What happens to us if we are bad-tempered?
Does the passionate child make the passionate man?
Is the passionate man a healthy man, or a good member of society?
What should we ever bear in mind?

GRATITUDE TO GOD.

When all thy mercies, O my God,
My rising soul surveys;
Transported with the view, I'm lost
In wonder, love, and praise.

Oh, how shall words, with equal warmth,
The gratitude declare
That grows within my ravished heart!
But thou canst read it there.

Thy providence my life sustained,
And all my wants redrest,
When in the silent womb I lay,
And hung upon the breast.

To all my weak complaints and cries
Thy mercy lent an ear,
Ere yet my feeble thoughts had learnt
To form themselves in prayer.

Unnumbered comforts to my soul
Thy tender care bestowed,
Before my infant heart conceived
From whence these comforts flowed.

When in the slippery paths of youth
With heedless steps I ran,
Thine arm, unseen, conveyed me safe,
And led me up to man;

Through hidden dangers, toils, and death.
It gently cleared my way;
And through the pleasing snares of vice,
More to be feared than they!

When worn with sickness, oft hast Thou
With health renewed my face;
And when in sin and sorrow sunk,
Revived my soul with grace.

Thy bounteous hand with worldly bliss
Has made my cup run o'er,
And in a kind and faithful friend
Has doubled all my store.

Ten thousand thousand precious gifts
My daily thanks employ;
Nor is the least a cheerful heart,
That tastes those gifts with joy.

Through every period of my life
Thy goodness I'll pursue;
And, after death, in distant worlds
The glorious theme renew.

When nature fails, and day and night
Divide thy works no more,
My ever-grateful heart, O Lord,
Thy mercy shall adore.

Through all eternity to Thee
A joyful song I'll raise,
For, Oh! eternity's too short
To utter all thy praise!—ADDISON.

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